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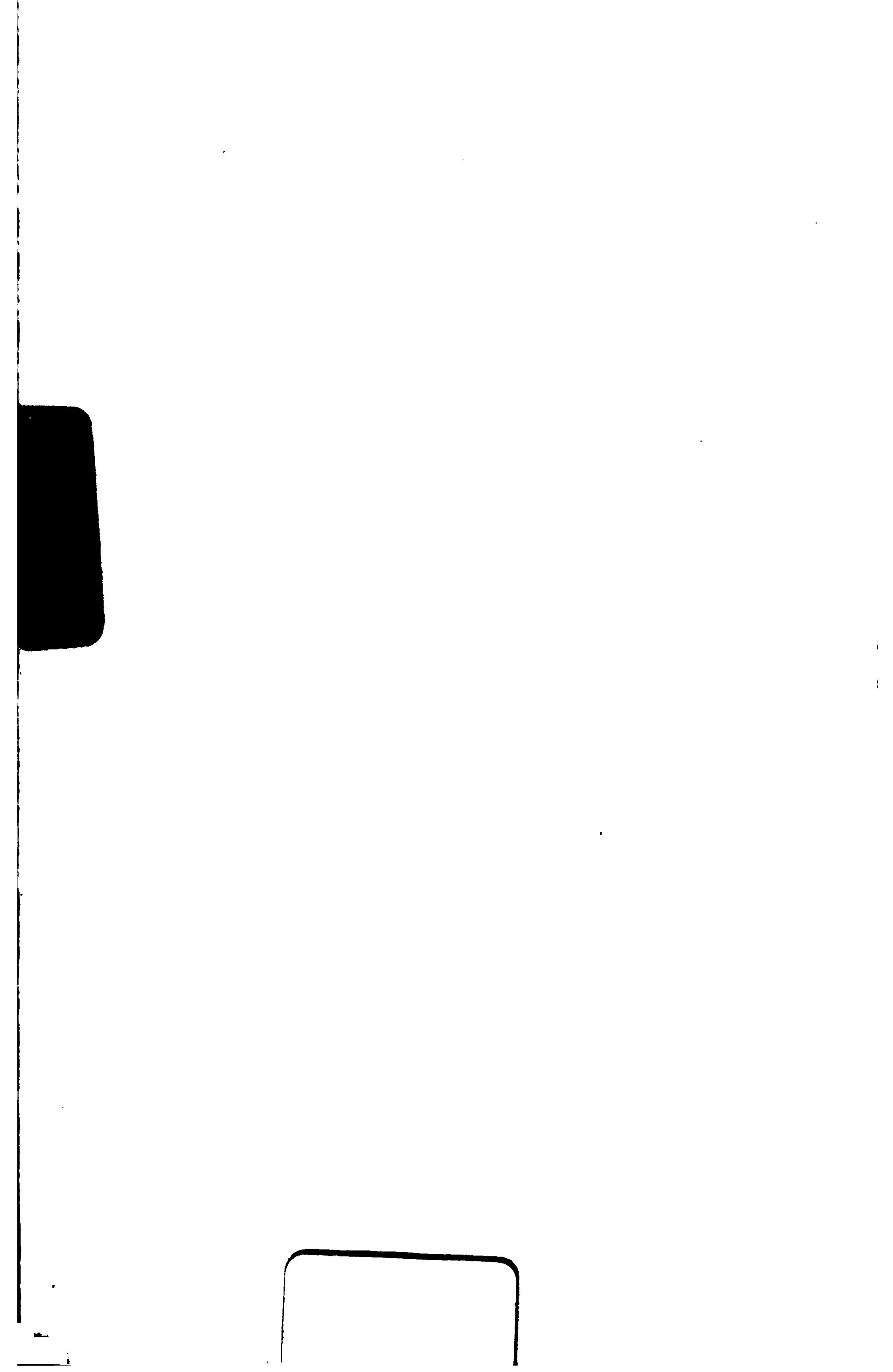
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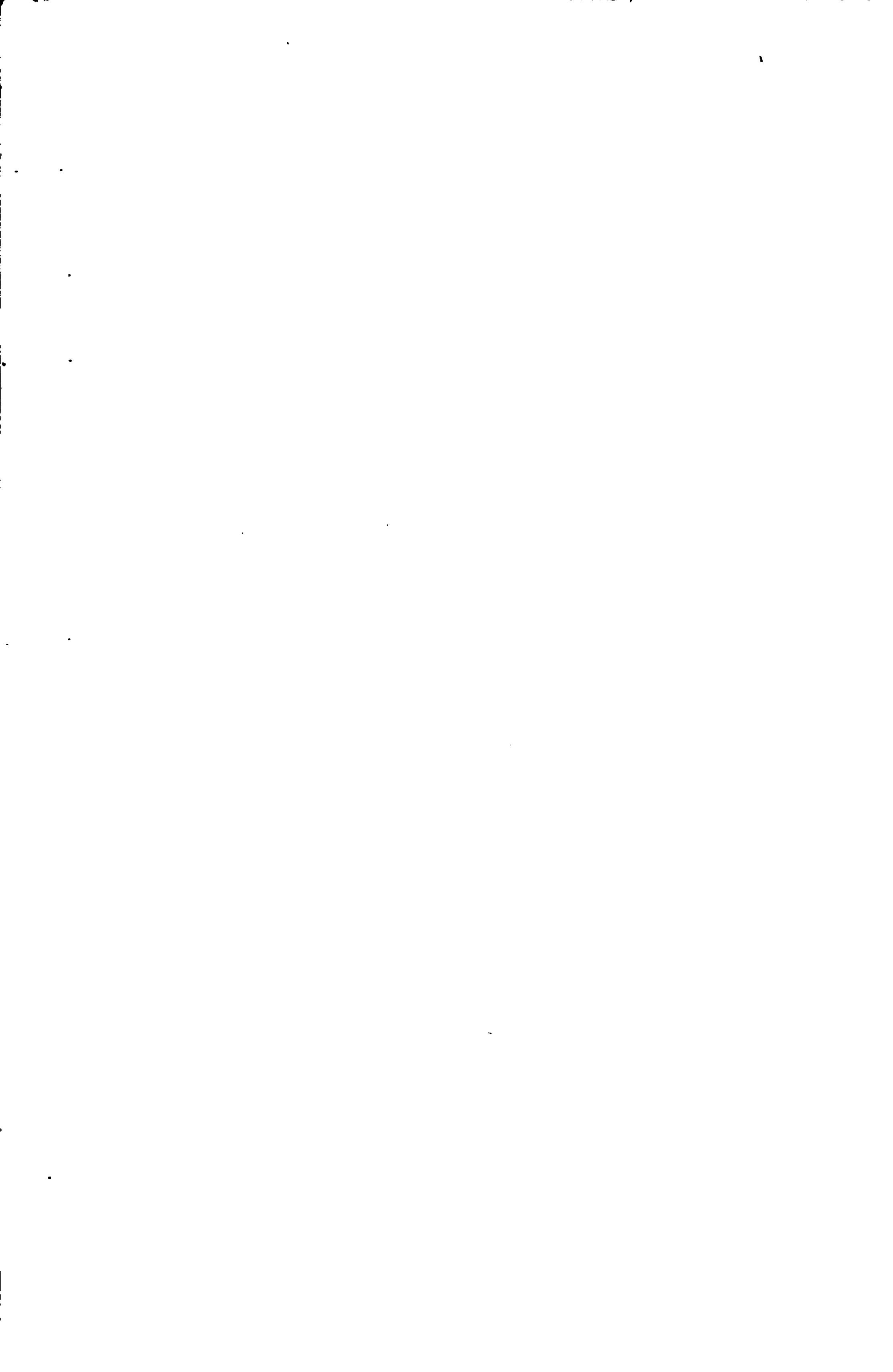
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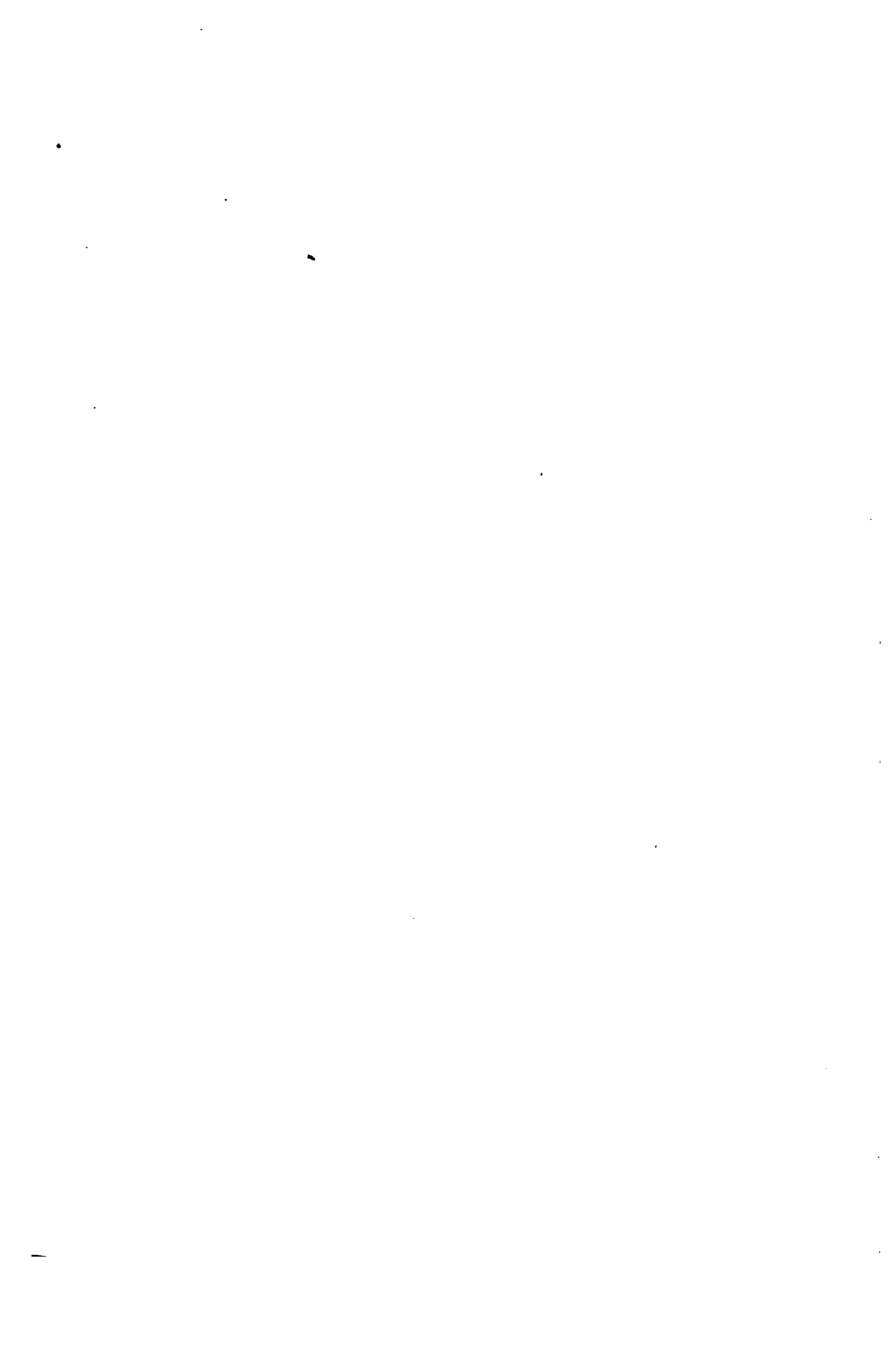
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TRANSACTIONS OF THE

SECTION ON

# Orthopedic Surgery



of the  
American Medical Association  
at the Sixty-Seventh Annual  
Session, held at Detroit,  
Michigan, June 13 to 16, 1916

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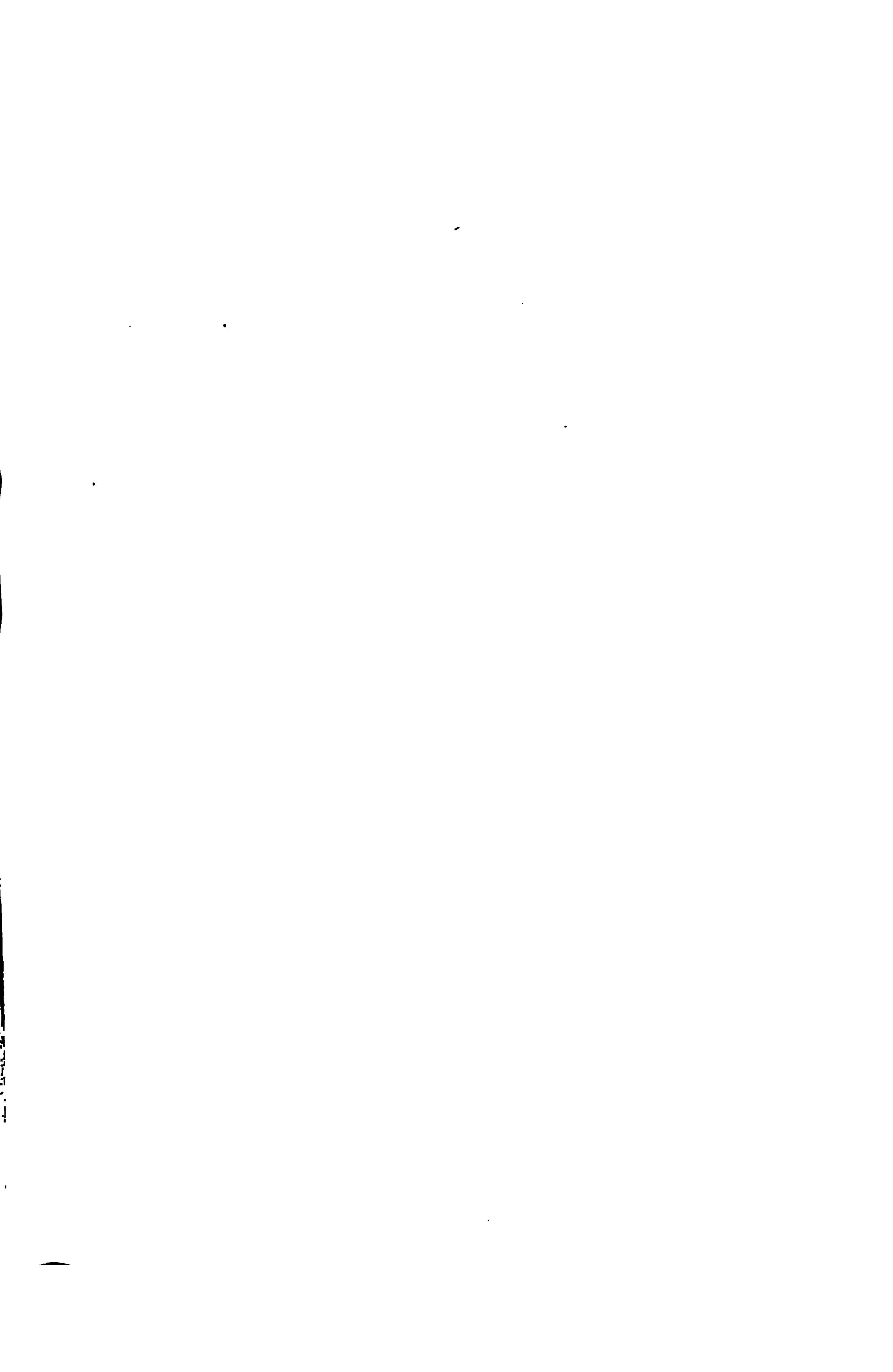
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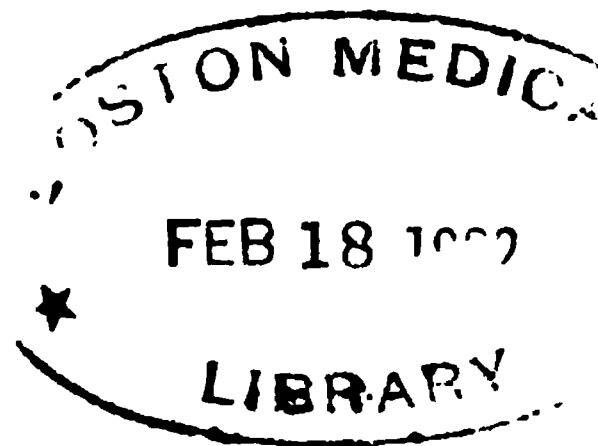
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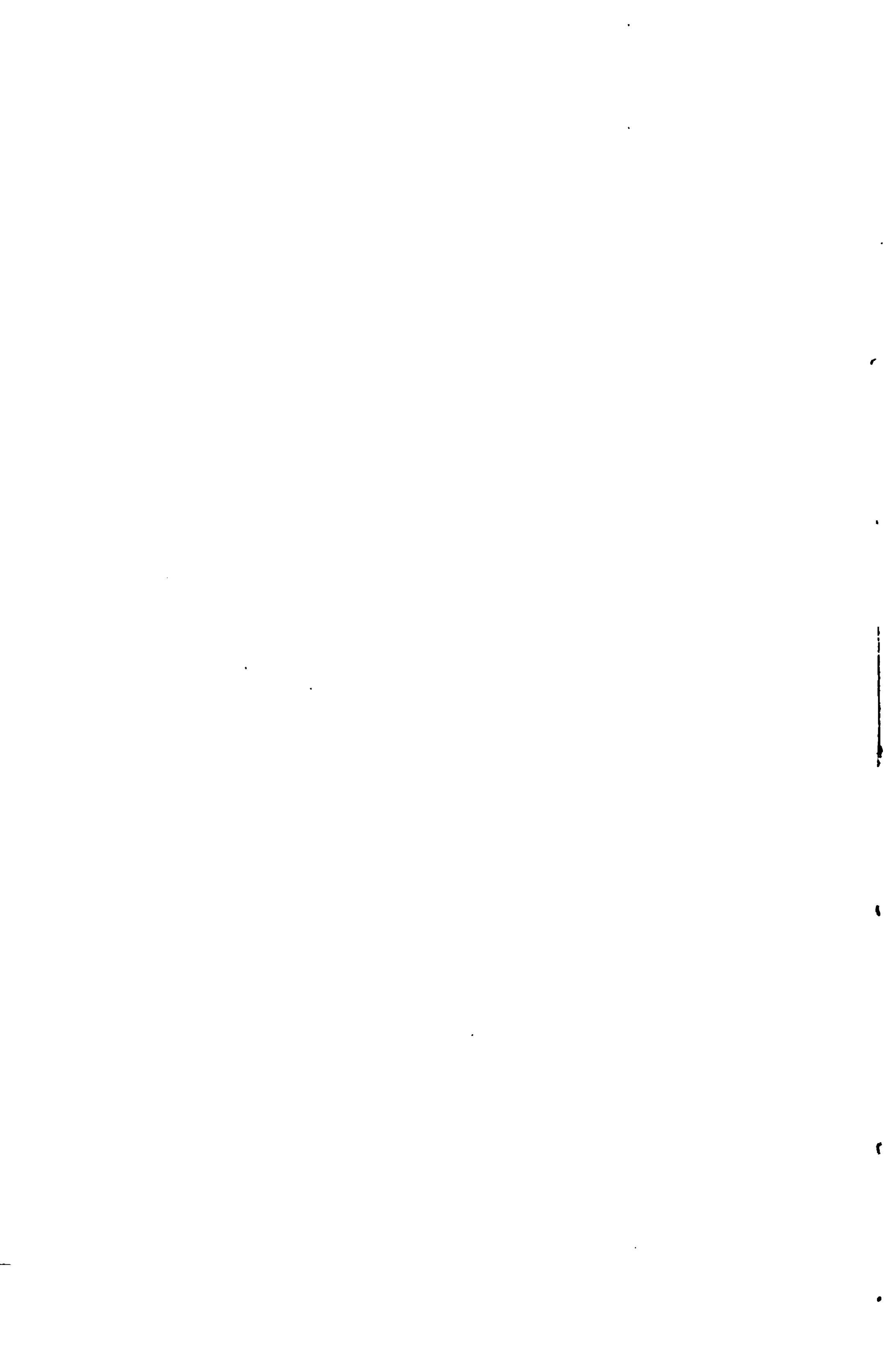
The Section was created in 1912, and has been served by the following officers:

- 1912-13 Chairman, Newton M. Shaffer, New York.  
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Vice Chairman, Robert B. Osgood, Boston.  
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Delegate, John Ridlon, Chicago.



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## PROCEEDINGS OF THE SECTION

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### TUESDAY, JUNE 13—AFTERNOON

The meeting was called to order at 2 o'clock by the chairman, Dr. Russell A. Hibbs, New York.

Dr. Russell A. Hibbs, New York, read the chairman's address, entitled "The Problem of the Chronic Cripple." No discussion.

Dr. Robert W. Lovett, Boston, read a paper on "The Treatment of Infantile Paralysis." Discussed by Drs. E. W. Ryerson, Chicago; H. W. Frauenthal, New York; Frederick C. Kidner, Detroit; Albert H. Freiberg, Cincinnati; F. J. Gaenslen, Milwaukee, Wis.; A. L. Fisher, San Francisco; James T. Watkins, San Francisco; W. G. Stern, Cleveland; W. R. MacAusland, Boston; C. A. Parker, Chicago; F. E. Peckham, Providence, R. I.; Roland W. Meisenbach, Buffalo; C. B. Francisco, Kansas City, Mo., and R. W. Lovett, Boston.

Dr. Frederick C. Kidner, Detroit, read a paper on "Calcified Hematoma: A Study of the Pathology." Discussed by Drs. W. C. Campbell, Memphis, Tenn.; James T. Watkins, San Francisco; J. D. Griffith, Kansas City, Mo., and Frederick C. Kidner, Detroit.

Dr. Wallace Blanchard, Chicago, read a paper on "Osteoclasis and Osteotomy." Discussed by Drs. J. Torrance Rugh, Philadelphia; Leonard W. Ely, San Francisco; Roland W. Meisenbach, Buffalo; Edward S. Hatch, New Orleans, and Wallace Blanchard, Chicago.

Dr. William R. MacAusland, Boston, read a paper on "Astragalectomy (Whitman's Operation) in Infantile Paralysis." Discussed by Drs. Frederick C. Kidner, Detroit; J. D. Griffith, Kansas City, Mo.; Albert H. Freiberg, Cincinnati; C. M. Jacobs, Chicago; E. W. Ryerson, Chicago; W. C. Campbell, Memphis, Tenn.; R. L. Hull, Oklahoma City; C. B. Francisco, Kansas City, Mo., and William R. MacAusland, Boston.

Dr. Walter G. Stern, Cleveland, read a paper on "The Prognosis in Infantile Paralysis." Discussed by Drs. H. W. Frauenthal, New York, and Walter G. Stern, Cleveland.

### WEDNESDAY, JUNE 14—MORNING

Dr. Willis C. Campbell, Memphis, Tenn., read a paper on "Localized Osteospondylitis." Discussed by Drs. F. J. Gaenslen, Milwaukee, Wis.; A. H. Freiberg, Cincinnati; Roland W. Meisenbach, Buffalo; J. T. Rugh, Philadelphia, and Willis C. Campbell, Memphis, Tenn.

Dr. Arthur L. Fisher, San Francisco, read a paper on "Syphilitic and Bone and Joint Lesions Simulating Tuberculosis." Discussed by Drs. H. W. Frauenthal, New York; John Ridlon, Chicago; James T. Watkins, San Francisco; Edward S. Hatch, New Orleans; E. W. Ryerson, Chicago; Walter T. Stern, Cleveland; Reginald H. Sayre, New York; Clarence B. Francisco, Kansas City, Mo.; Leonard W. Ely, San Francisco; Emil S. Geist, Minneapolis; H. L. Taylor, New York; A. E. Horwitz, St. Louis, and Arthur L. Fisher, San Francisco.

Dr. Leonard W. Ely, San Francisco, read a paper on "Ankylosing Operations on the Spine." Discussed by Drs. Russell A. Hibbs, New York; Reginald H. Sayre, New York; James T. Watkins, San Francisco; E. W. Ryerson, Chicago; J. Torrance Rugh, Philadelphia, and Leonard W. Ely, San Francisco.

Dr. Henry Ling Taylor, New York, read a paper on "Results of Research on Conditions Affecting Posture." Discussed by Drs. Joel E. Goldthwait, Boston; E. W. Mosher, Brooklyn; Walter G. Elmer, Philadelphia; Roland O. Meisenbach, Buffalo; S. A. Knapp, New York, and Henry Ling Taylor, New York.

Dr. Melvin S. Henderson, Rochester, Minn., read a paper on "Mechanical Derangements of the Knee Joints." Discussed by Drs. John Ridlon, Chicago; J. P. Lord, Omaha; Willis C. Campbell, Memphis, Tenn.; Robert B. Osgood, Boston, E. W. Ryerson, Chicago; James T. Watkins, San Francisco, and Melvin S. Henderson, Rochester, Minn.

#### WEDNESDAY, JUNE 14—AFTERNOON

Dr. Mark H. Rogers, Boston, read a paper on "Sciatica: An Analysis of Fifty Cases." Discussed by Drs. Leonard W. Ely, San Francisco; Melvin S. Henderson, Rochester, Minn.; Joel E. Goldthwait, Boston; Roland O. Meisenbach, Buffalo; John Ridlon, Chicago; J. D. Griffith, Kansas City, Mo.; E. W. Ryerson, Chicago; Frank E. Peckham, Providence, R. I.; James T. Watkins, San Francisco; Albert H. Freiberg, Cincinnati; Reginald H. Sayre, New York; A. L. Fisher, San Francisco, and Mark H. Rogers, Boston.

Dr. E. W. Ryerson, Chicago, read a paper on "Fat Embolism in Bone Surgery: Incidence and Control." No discussion.

Dr. Robert B. Osgood, Boston, read a paper on "Orthopedic Surgery in War Time." Discussed by Drs. Nathaniel Allison, St. Louis; E. W. Fiske, Boston; J. D. Griffith, Kansas City, Mo.; Joel E. Goldthwait, Boston; J. Torrance Rugh, Philadelphia; John Ridlon, Chicago, and Henry W. Frauenthal, New York.

It was moved that Dr. Osgood be allowed all the time necessary to present his slides. Motion carried.

Drs. Robert E. Humphries and Henry A. Durham, New York, read a paper on "The End-Results of Tuberculosis of the Spine, Hip, Knee and Ankle Joints from the Records of the New York Orthopedic Dispensary and Hospital." Discussed by Drs. John Ridlon, Chicago; Reginald H. Sayre, New York; Charles M. Jacobs, Chicago, and Robert E. Humphries, New York.

Dr. Albert H. Freiberg, Cincinnati, read a paper on "The Evolution of Osteochondritis Deformans Coxae Juvenilis." Discussed by Drs. J. R. Kuth, Duluth, Minn.; Frederick C. Kidner, Detroit; John Ridlon, Chicago; Virgil P. Gibney, New York; H. L. Taylor, New York, and Albert H. Freiberg, Cincinnati.

Dr. Albert Ehrenfried, Boston, read a paper on "Hereditary Deforming Chondrodysplasia—Multiple Cartilaginous Exostoses." Discussed by Drs. Albert H. Freiberg, Cincinnati, and Albert Ehrenfried, Boston.

Dr. Charles A. Parker, Chicago, read a paper on "A Plea for the Prevention of Deformities Following Burns." Discussed by Drs. J. P. Lord, Omaha; Charles M. Jacobs, Chicago, and Charles A. Parker.

#### THURSDAY, JUNE 15—MORNING

On motion, the reading of the minutes of the previous executive session was dispensed with, and they were referred to the Executive Committee. Motion carried.

The following officers were elected: chairman, Dr. E. W. Ryerson, Chicago; vice chairman, Dr. Robert B. Osgood, St. Louis; secretary, Dr. Emil S. Geist, Minneapolis; delegate, Dr. John Ridlon, Chicago; alternate, Dr. Leonard W. Ely, San Francisco.

Dr. Ely, chairman of the Committee on Tuberculosis, reported that the committee had not done its work and was not ready with a report. On motion the committee was continued. Motion carried.

The Committee on Crippled Children, through its chairman, Dr. Nathaniel Allison, St. Louis, presented a report. It was not read in full, but only the concluding part, containing the recommendation of the committee. This report will be sent to the Association. A discussion ensued. On motion of Dr. Griffith, the report was received and adopted. Motion carried. A motion was then made that the committee formulate a resolution to be transmitted to the House of Delegates, and that the secretary be instructed to see that this was given to Dr. Ridlon for presentation at once. The motion was carried.

The secretary made a statement concerning the proper way for those desiring to obtain copies of the Transactions to proceed. He then brought up the subject of a letter that he

had received, suggesting that the length of the meeting and the number of papers of the section be curtailed. Dr. Freiberg, in this connection, offered a resolution relative to the work of the section, which was referred to the House of Delegates.

Under new business, Dr. Allison made a motion that a committee consisting of five members, including the chairman and Dr. Goldthwait, as chairman, be appointed to consider, with the Committee of the American Orthopedic Association, the best method of establishing a system of preparedness in orthopedic surgery in this country. The motion was carried. Dr. Hess appointed, as the other three members of this committee, Drs. Melvin S. Henderson, Robert B. Osgood and Nathaniel Allison.

Dr. Charles M. Jacobs, Chicago, read a paper on "Compression Paralysis of Pott's Disease in Adults." Discussed by Drs. Henry W. Frauenthal, New York; J. Torrance Rugh, Philadelphia; A. L. Fisher, San Francisco; Reginald H. Sayre, New York; F. J. Gaenslen, Milwaukee, Wis.; James T. Watkins, San Francisco; Edward S. Hatch, New Orleans; Albert H. Freiberg, Cincinnati; C. M. Jacobs, Chicago, and Reginald H. Sayre, New York.

Drs. Nathaniel Allison and Herbert H. Hagan, St. Louis, presented a paper on "The Operative Treatment of Tuberculosis of the Spine." Discussed by Drs. Fred H. Albee, New York; J. Torrance Rugh, Philadelphia, and James T. Watkins, San Francisco.

Dr. John Ridlon, Chicago, read a paper on "A Report of Two Cases of Scoliosis with Pressure Paraplegia." Discussed by Drs. Leonard W. Ely, San Francisco; J. D. Griffith, Kansas City, Mo., and Reginald H. Sayre, New York.

Dr. George W. Hawley, Bridgeport, Conn., read a paper on "New Methods of Precision in the Treatment of Fractures."

Dr. Frank E. Peckham, Providence, R. I., read a paper on "The Treatment of Some Fractures of the Femur."

These two papers were discussed by Drs. Fred H. Albee, New York; James T. Watkins, San Francisco; J. Torrance Rugh, Philadelphia; John Ridlon, Chicago; H. R. Allen, Indianapolis; J. S. A. Gerster, New York; E. W. Ryerson, Chicago, and Frank E. Peckham, Providence, R. I.

## THE PROBLEM OF THE CHRONIC CRIPPLE\*

RUSSELL A. HIBBS, M.D.  
NEW YORK

The increasing interest throughout the country in the problem of the chronic cripple creates an opportunity for this section to be of great service in shaping the future development of work for this class of sufferers. As knowledge of the fact that there are large numbers of people in every community who need orthopedic care increases, and as methods of treatment are perfected, a large number of men are going to select orthopedic surgery as a specialty, and will seek opportunities to equip themselves for this work. It seems to me that we of this section should be able to furnish some suggestions to such men in determining the nature of their equipment, and the best means of applying it to the needs of the cripple. In answering such questions, the fact must be emphasized that almost all our work in orthopedic surgery has to do with the treatment of the chronic sufferer, which means that our results are long delayed, often requiring years of painstaking care to detail for their accomplishment, and may be secured only by men giving the same enthusiastic consideration to the treatment of these patients which is so easily given to the treatment of the acutely ill. In other words, we have got in some way to keep ourselves working under the inspiration of a chronic enthusiasm as the only means by which we can meet the tremendous difficulties in the treatment of chronic diseases. Not only is such enthusiasm important on the part of the surgeon, but also it is of

\* Chairman's address.

immense importance in its influence on our patients. If it is tiresome and discouraging to the surgeon to find results long delayed, how much more so is it apt to be to the patients themselves.

Such enthusiasm is of slow growth, and suggests that the orthopedic surgeon as compared with the general surgeon should have a longer period of preliminary preparation. Not only is this necessary for the development of a spirit of enthusiasm but also is it best for technical equipment.

As has been indicated, the results of our methods of treatment are slow in showing, and a thorough knowledge of them cannot be obtained except by studying the individual case for a considerable time in varying conditions of treatment, in the hospital, dispensary and home. The great volume of work for the cripple is done in the outpatient or dispensary department, and careful training in this work is as necessary as in the hospital. A large number never have any hospital treatment at all, and those who are admitted to the hospital stay for a short time in comparison with the duration of treatment, and under modern conditions, except in the case of country hospitals for joint tuberculosis, most orthopedic patients are admitted to the hospital for some form of operative treatment. During the past year I have made inquiries of seven clinics in various parts of the country as to the total number of patients treated in each clinic and what proportion of that number were admitted to the hospital for operation. The results of these inquiries have been most surprising, because in the larger clinics, and those which have been longer established, the percentage of patients admitted to the hospital for operation of the total number treated in the dispensary varied from 3 to 10 per cent. In a few instances, the percentage was as high as 18. The average percentage for the whole number was 10.

These facts have an important bearing on the question we are discussing. If the man's training is only in

the hospital, his preparation for the treatment of the 90 per cent. of the cases which never enter the hospital is poor. There is a great deal more written about the 10 per cent. who have operations than the 90 per cent. who do not, and I think therein lies a danger to the future development of our specialty, that in the consideration given to the operative side of the work, we may neglect the nonoperative. I am not attempting to raise any question as to the value of operations in orthopedic surgery. There can no longer be any question that the operative aspect of our work is of great importance. All I am concerned about is that the vastly larger volume, the nonoperative, be not neglected. As a matter of fact, the greatest possible operative skill will be defeated in the accomplishment of the greatest amount of good for our patients, unless the man who exercises it has taken pains long before to perfect his equipment in the much more difficult and much more tedious nonoperative work.

Assuming, therefore, the proper training of the man, our second question is, What is the best means of applying it to the needs of the cripple?

This brings us to the question of organization, and I feel sure that from the standpoint of the cripple and his needs, the orthopedic surgeon can be more effective in meeting them in institutions wholly devoted to the treatment of the cripple. There are many communities throughout the country where such work is new and unfamiliar to the profession and the laity, and such places offer wonderful opportunities for men to initiate organizations ideally fitted to the need of the cripple, unhampered by the difficulties of attempting to do work for the cripple in a small and insignificant orthopedic department in a general hospital, the spirit and atmosphere of which I do not believe is most helpful to work of this kind.

130 East Thirty-Sixth Street.

## OSTEOCLASIS AND OSTEOTOMY

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WALLACE BLANCHARD, M.D.

Assistant Clinical Professor in Surgery (Orthopedic), Rush Medical College; Orthopedic Surgeon to the Home for Destitute Crippled Children, the University Hospital and the Country Home for Convalescent Children, Prince Crossing, Ill.

CHICAGO

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Osteotomy is the oldest and the most popular operation for the correction of severe rachitic deformities of the legs in children, yet it has many disadvantages when compared with osteoclasis performed with the aid of the perfected Grattan osteoclast. Some of its disadvantages are: the production of a compound instead of a simple fracture; time required for operation; the danger of infection which, though it may be slight, nevertheless exists; time, care and expense necessary for antiseptic precautions, and the pain that always accompanies an open wound. But the most serious objection to osteotomy is the delayed union as compared with union after osteoclasis. This is undoubtedly due to the severing of the continuity of the bone shaft and the carrying of soft tissue into the open space with the chisel. This delayed union has frequently to be supplemented by postoperative treatment, which is never required after rapid osteoclasis.

Tubby<sup>1</sup> says that "nonunion after osteoclasis is scarcely, if at all, known, whereas it is seen from time to time after osteotomy."

Neither osteotomy nor osteoclasis should be performed on rachitic bone during the subacute stage. The roentgenogram will show a clearly outlined epiphysis when lime is deposited sufficiently to produce a fair degree of eburnation.

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1. Tubby, A. H.: *Deformities, Including Diseases of the Bones and Joints*, London, 1914.

Under favoring conditions of a raw food diet and fresh air, eburnation is usually a process of only weeks or months.

The earliest observers noticed that knockknee produced flatfoot, but the fact practically escapes attention that a mild degree of knockknee, that is just noticeable in the child, will frequently be sufficient in adult life to throw the center of gravity inside the inner border of the foot and produce a disabling flatfoot. In such cases the only remedy must be a supracondylar osteotomy, which the adult patient invariably looks on with abhorrence. This emphasizes the necessity of correcting mild knockknees in children when a slight supracondylar bending in the osteoclast will produce an ideal correction. Experience shows that the lower end of the femur will bend in the osteoclast without fracture several years after eburnation has become so complete in the tibia that it will fracture with a loud snap. Osteokampsis is the name given by Adolph Lorenz to the bending and stretching of bone without fracture.

Figure 1 (Case 1) presents pronounced knockknees, and the roentgenogram (Fig. 2), taken two months after correction by osteokampsis, shows that the lower ends of the femoral shafts took extreme inbends without fracture, and Figure 3 shows the same patient with symmetrical legs and the pronated feet corrected.

Bowlegs in a child should never be corrected by osteotomy for the reason that an angular deformity is left, at the point where the chisel entered the bone.

In France I have seen bowleg cases in which attempts had been made to overcome the angularity left by osteotomy by driving the chisel into the bones of the legs at several different locations.

Unfortunate attempts are occasionally made to correct deformities of the legs by osteoclasis or osteotomy of the tibia without fracturing the fibula. The fibula always participates in the deformity, and the unfrac-

tured fibula usually neutralizes attempts to lengthen or correct a deformed tibia.

The deformity of bowleg is usually an exaggeration of the normal outbend of the lower femoral shaft, and a more pronounced and long distributed outbend of the tibial shaft.

In osteoclasis for the correction of bowlegs the pressure bar should be placed opposite the apex of the outbend and against the outside of the leg, to insure the prompt bending or fracturing of the fibula at the same time as the tibia. Then a few quick turns of the screw gives the tibia a long distributed inbend curve. Even in well eburnated bones this overcorrection is frequently accomplished sufficiently to rectify the local deformity, and also to neutralize the other outbends without any fracture whatever. When fracture does take place it is only after the bone has bent a long way toward overcorrection, and the roentgenogram will show that the fracture is only subperiosteal and partial. The distributed corrective curve should be held in plaster of Paris for five weeks, and the result will invariably be symmetrical and functionally perfect legs. Figure 4 (Case 2), Bernard G., presents pronounced bowlegs, and the roentgenogram of the case after correction (Fig. 5) shows that the tibias took a long distributed overcorrection inbend without fracture, and Figure 6 of the same case shows symmetrical and useful legs.

All the American textbooks agree that "osteotomy is more satisfactory" for the correction of anterior bent tibias, for the reason that very few operators appreciate the ease and rapidity with which anterior bent tibias can be bloodlessly corrected by the modern method of rapid osteoclasis.

For the correction of anterior bent tibias the pressure bar of the osteoclast should be placed opposite the apex of the deformity and against the outside of the leg. The fracture of the tibia and fibula should be in the direction of the least resistance and should be

complete in eight seconds, and the deformity corrected by manual force and ready for plaster of Paris in another eight seconds. Symmetrical and functionally perfect legs will almost invariably result.

Figure 7 (Case 3) presents anterior bent tibias; the roentgenogram (Fig. 8), taken two months after correction, shows dark shadows of dense new bone filling the opened spaces in the tibias, and Figure 9 shows the same patient with symmetrical and useful legs.

It should be remembered that any operation that lengthens the leg must be preceded by a tenotomy of the Achilles tendon. If this precaution is neglected, the strong pull of the tendon will prevent a good correction, and a tenotomy will have to be done later to let the heels down to the floor.

Osteotomy is the only available operation for the correction of bone deformities of all patients over 12 years of age, and when the bones have been eburnated to an abnormal strength.

In adult life the soft parts do not stretch as readily and the bones have lost the pliability of childhood.

For the correction of anterior bent tibias in the adult, cuneiform osteotomy is the only practical operation.

For the correction of knockknees in the adult the McEwen supracondyloid osteotomy is usually preferred.

Figure 10, Nettie Z., aged 13 years, came into the service of Drs. Blanchard and Parker at the Home for Destitute Crippled Children, showing an anomalous case of neglected rachitic deformity with the general appearance of bowlegs and a tilt of the body to the right. The lower ends of the femoral shafts were twisted full 90 degrees, so that the patellas looked directly outward. There was a marked anterior bend in the lower third of the shaft of the right femur, but both tibias remained normally straight. When the patient flexed either knee the foot came up in front of the opposite leg, making locomotion impossible. After supracondyloid osteotomy the condyles were rotated

inward 90 degrees and the legs put into plaster of Paris in a straight position with the condyles of the right femur tilted forward. When the plaster was removed six weeks later, the legs were found to be symmetrical, and locomotion was perfect.

It is the position in which the legs are put in plaster of Paris after either an osteotomy or osteoclasis that determines both the anatomic and functional result.

While osteotomy has a broader field of usefulness than osteoclasis, there should be a more universal appreciation of the fact that a slight bending of the pliable bones of young children will usually correct bad rachitic deformities of the legs, and that they should not be unnecessarily subjected to the more severe and trying operation.

15 East Washington Street.

#### ABSTRACT OF DISCUSSION

DR. J. TORRENCE RUGH, Philadelphia: I have nothing but commendation for the paper and there are one or two points in it that should be emphasized. One is that if the bones, in osteoclasis, are not entirely fractured, overcorrection must be the rule. It has been my experience that unless the bone is bent to the position of overcorrection, there is so much tension of the soft parts afterward that pressure-sores may develop over the bony parts. Another point is that for the general surgeon, or the man who is not so well equipped in paraphernalia as is a man who confines his work entirely to orthopedic surgery, the possession of an osteoclast is not always possible and may not always be necessary. For such individuals, I think that the operation of osteotomy will prove just as satisfactory as osteoclasis. A bone may be bent after it has been partially severed, and if the osteotome is driven through one half of the bone, the rest of the bone, by careful twisting with the hand, may be bent in the manner desired. For an outward bend, the inner plate should be cut through, and vice versa. In this manner, an incomplete fracture may be secured with the osteotome as well as by an osteoclast; and the result is as satisfactory in every way. The disadvantage of an open wound is practically a negative one. There is one criticism that I wish to offer. It is a plea for the presentation of photographs of these reported cases in such a way that the audience can get a true estimate of them.

**Fig. 1** (Case 1)—Knockknees producing flat and pronated feet.

**Fig. 2**—Roentgenogram in Case 1 two months after an eight second supracondyl bend without fracture in the Grattan osteoclast.

**Fig. 3** (Case 1)—Six weeks after bloodless correction of the knockknees, showing arches of the feet restored.

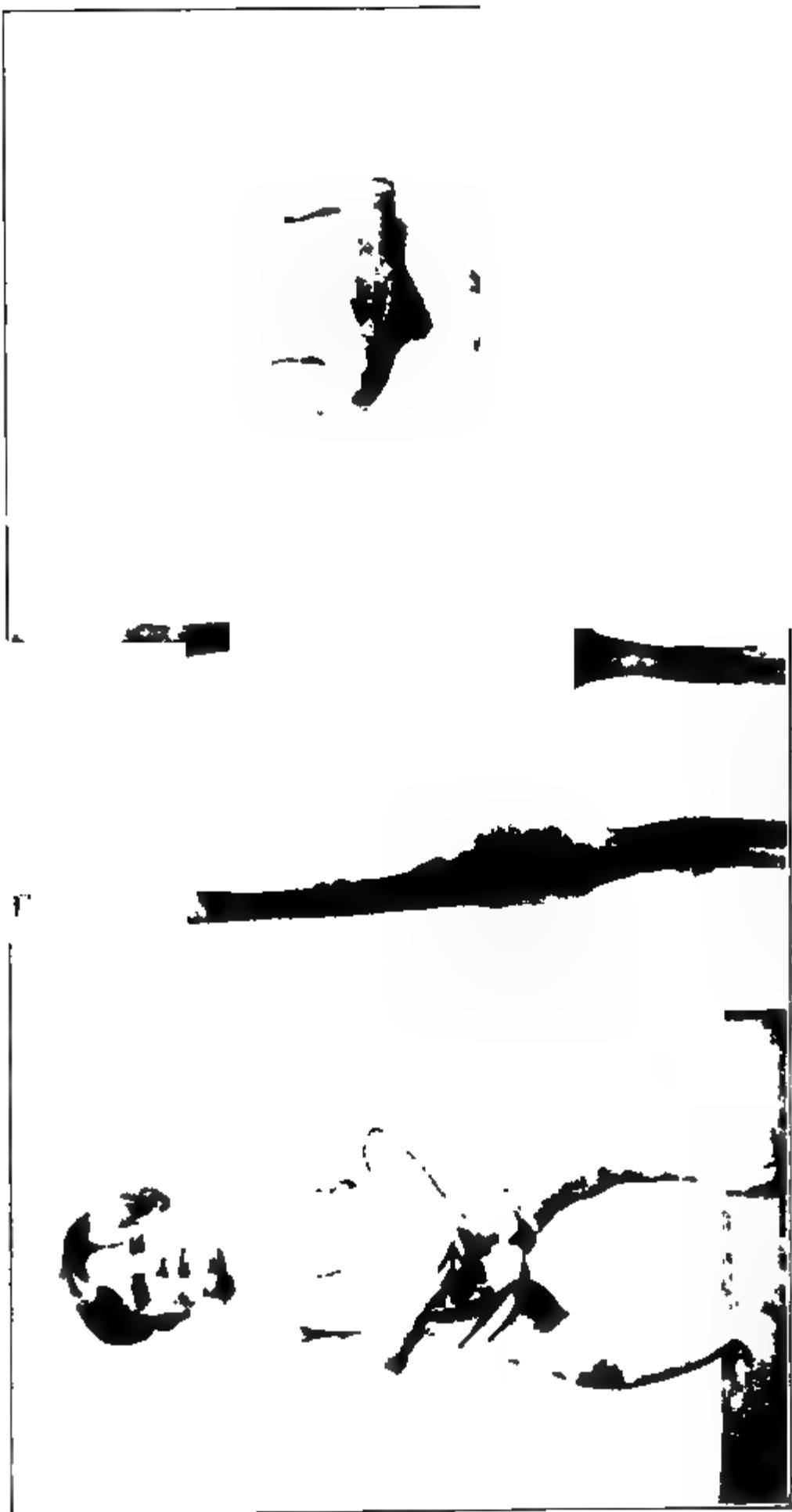


Fig. 4 (Case 2).—Bowlegs; patient standing with the feet widely apart in the voluntary attempt to bring the outrolled feet on a plane with the floor.

Fig. 5.—Roentgenogram in Case 2 after an eight second bloodless overcorrection in the osteoclast without fracture.

Fig. 6 (Case 2).—Six weeks after rapid bloodless osteokampsis, showing that both the bowlegs and the abducted feet have been corrected

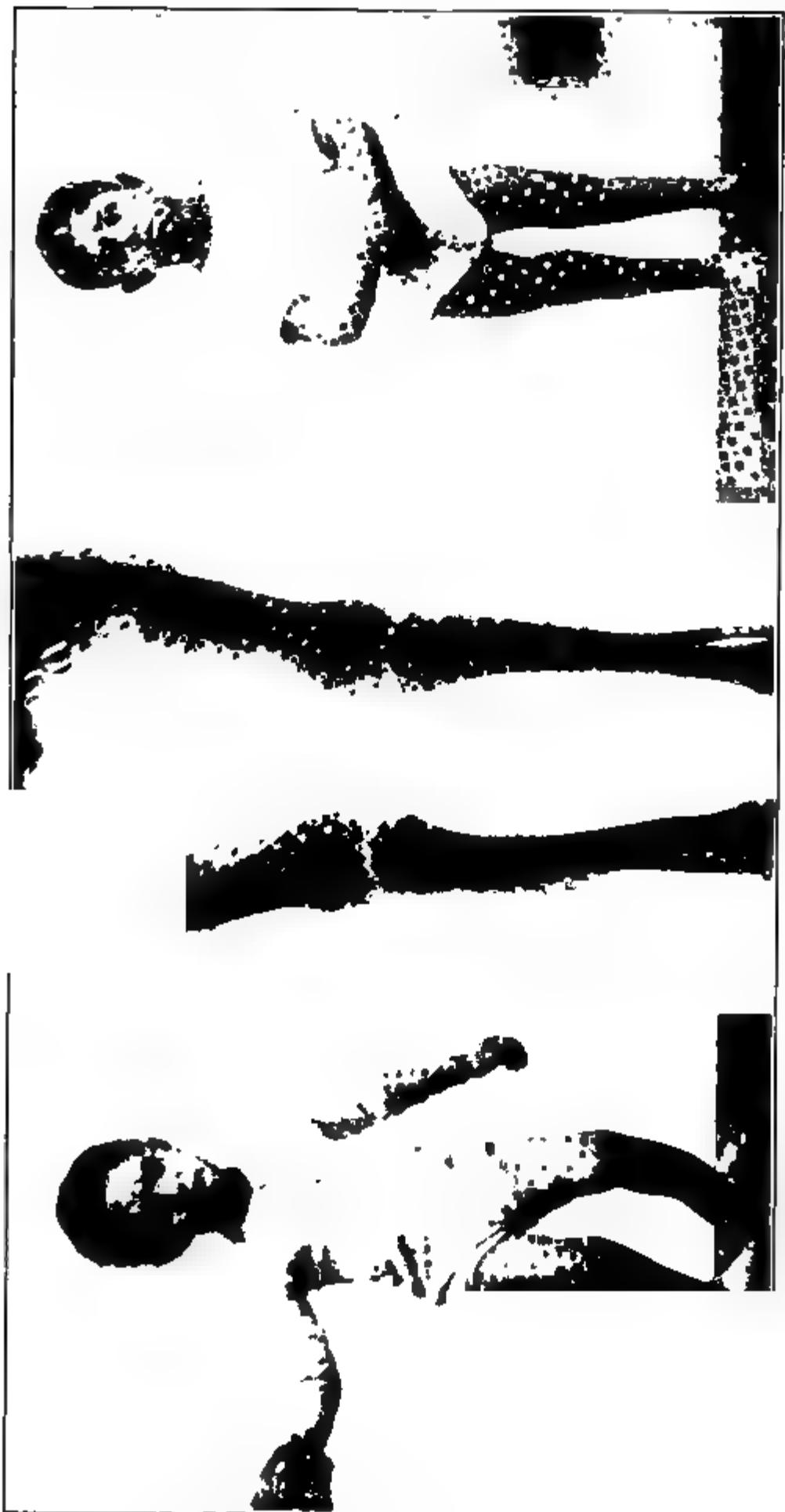


FIG. 7 (Case 3).—Anterior bent tibias.

Fig. 8 Roentgenogram in Case 3 taken two months after correction, showing dark shadows of dense new bone filling opened spaces in the tibiae.

Fig. 9 (Case 3).—After rapid bloodless osteoclasis, showing symmetrical and use fit legs.

**Fig. 10 (Case 4).—Rachitic twisted femurs simulating bowlegs.**

**Fig. 11 (Case 4).—After a McEwen osteotomy and redressment, showing symmetrical and functionally perfect legs.**

**DR. CHARLES A. PARKER, Chicago:** Dr. Blanchard spoke of the rarity of nonunion in osteoclasis. I have a case that is not united yet. It was put in position after simple osteoclasis, without difficulty, and without any displacement; but it has not united yet, after two or three years. As to the number of bones that may be broken at one time, it was set at four by Dr. Blanchard. Recently, however, in a little colored girl, who had an anteriorly bent tibia and knock-knees, we broke both bones in the right leg, both bones in the left, and both thigh bones at one operation. She is doing well.

**DR. EDWIN W. RYERSON, Chicago:** There is one point about osteoclasis that should be realized, and that is, that we cannot do it in all bow-leg cases, because a certain number of these cases have the bend so low in the tibia that it is not safe to use the osteoclast. In cases in which the deformity is very low, the osteoclast may slip over the end of the bone and injure the joint, so that it is better in these cases to do an osteotomy. I do not like to do osteoclasis on the femur. We cannot get the line of fracture quite close enough to the lower end of the femur. I have felt that there was danger in doing an osteoclasis of the lower end of the femur; and it has, therefore, been my custom, for seventeen or eighteen years, to do an osteotomy in all cases of knock-knees with the deformity in the femur. I have seen no nonunions or infections, or any other untoward result whatever, and I regard this procedure as just about as safe, except on theoretical grounds, as osteoclasis. The Rizzoli osteoclast is much slower than the Grattan. It used to be employed in the Children's Hospital in Boston. The Grattan osteoclast, which we use in Chicago, is excellent. I have used it in many cases, and do not hesitate to employ it in the cases of children up to the age of 12 years. I used it a few days ago in the case of a strong girl of 12 with eburnated tibias and in this instance, it made a slight tear in the skin over the tibia. This has never before happened with me, but I have seen other surgeons make slight tears in the skin with osteoclasts. Of course, such a lesion in skin that is unprepared, as is the case when osteoclasis is performed, is more serious than is a skin wound by a chisel or knife when the surface has been thoroughly prepared for operation.

**DR. ROLAND MEISENBACH, Buffalo:** I was interested to hear Dr. Blanchard say that osteoclasis could also be applied to the antero-posterior bow-legs. Owing to the tensity of the Achilles tendon, I have been in the habit of doing osteoclasis on lateral bow-legs and using the osteotome on antero-posterior. I believe it is quite possible to do the osteoclasis near the epiphysis, if one is careful in the use of the osteoclast. I use the Grattan osteoclast, and the success of much of the work depends on the quickness and power of

the osteoclast; also on the quickness with which the operator stops the osteoclast after correction has been established. For this reason, I have had my osteoclast so modified that its handle is dumb bell shape, giving greater force and momentum to the machine. I believe osteoclasis has many advantages over osteotomy in many instances.

DR. EDWARD S. HATCH, New Orleans: In my part of the country we have bow-legs and knock-knees always with us. I have been doing about half of my cases by osteoclasis and half by osteotomy, and have not been able to see any marked difference in the results. In small children, I break the bones by hand and the results seem to be as good as those from osteoclasis.

DR. WALLACE BLANCHARD: Rachitic deformities have fallen off about 60 per cent. in Chicago since immigration has declined on account of the war. The children that are brought from warm climates to America get along well and do not develop rickets, but the children born of recent immigrants from Italy and Greece develop severe rickets. I found, at one time, that 50 per cent. of all of our cases came from Italy, Greece and Syria. We get many rachitic deformities in colored children coming from the far South. Concerning correction and overcorrection, we put up severe cases of bow-legs so that they look like knock-knees while they are in plaster, so thoroughly are they overcorrected, and we put up knock-knees so that they look like bow-legs in plaster. A good share of the apparent overcorrection is lost in the plaster and under the cotton lining of the plaster. In regard to nonunion: The roentgenograms show a well-defined epiphysis when the case has eburnated sufficiently to be past the danger of rachitic nonunion. Dr. Parker's case was probably still in the subacute stage. That was very likely the reason why he got nonunion, although the boy was old enough for complete eburnation to have occurred.

## A PLAN OF TREATMENT IN INFANTILE PARALYSIS

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ROBERT W. LOVETT, M.D.  
BOSTON

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The successful treatment of infantile paralysis requires that the surgeon should have in his mind a definite plan covering all the phases of the disease, a plan based on the pathology in its various phases. We have at the outset a virulent acute affection with a high mortality, then comes a period of two years during which we try to restore to their highest efficiency the affected muscles, and finally we meet in the later and so-called stationary stage of the affection the question of correcting deformity and restoring or improving function by operative measures. Few affections offer a wider range of requirements from a therapeutic point of view, and if when we are treating the first stage we bear in mind what may happen to the patient in the third stage, we shall treat the early stages better.

The muscle test spoken of in the paper is a means of quantitatively estimating the strength of muscles by means of their pull against a spring balance, and is not only useful in locating the existence of weakness in different muscular groups, but offers a means of estimating the gain or loss in muscular strength under given conditions.<sup>1</sup>

The stages of the disease are as follows:

1. The stage of onset begins with the acute attack, and may be assumed to end when the tenderness has disappeared, a duration in general of from four weeks to three months. A hemorrhagic myelitis is present,

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1. Martin, E. G., and Lovett, R. W.: A Method of Testing Muscular Strength in Infantile Paralysis, THE JOURNAL A. M. A., Oct. 30, 1915, p. 1512.

widespread, and affecting chiefly the centers of motion. The centers of sensation are also involved, the posterior root ganglia in experimental pathology showing the first changes, and the existence of tenderness must be accepted as evidence of an active process in the spinal cord. During this tenderness it is not physiologically reasonable to excite the peripheral connections of the affected nerve centers by massage and electricity. The former at times causes great increase of pain and soreness, and has nothing to recommend it at this stage, and there is no evidence whatever to show that electricity is of any value at this stage. Rest is the physiologic requirement, and the method of treatment that in practice works best, and the growing tendency to omit meddlesome therapeutic measures at this stage is hopeful. There is evidence that the use of hexamethylenamin in monkeys diminishes the risk of infection, but has no effect after the paralysis has occurred, and as the drug in moderation is harmless, it is extensively used in this stage. There is no serum or drug or proceeding that is known to abort the affection or limit the paralysis, although Netter of Paris has administered intraspinal injections of the blood of recovered persons with, he believes, benefit, but only in a small series of cases, and the proceeding is as yet wholly in the experimental stage.

During this stage the patient should be kept quiet. Joints will not stiffen, hopeless muscular atrophy will not occur, and by this proceeding the damaged cord will have the best chance to repair, and repair to the highest degree is desirable.

Deformities should be prevented by keeping the feet at right angles to the legs to avoid the most common deformity, a dropped foot. Toward the end of this period immersion in a warm salt bath is desirable and permits a degree of exercise to the affected limbs. Scoliosis begins frequently in this stage, and is often overlooked.

2. The second stage, or phase of convalescence, may be assumed to begin with the disappearance of the tenderness and to last for two years or more, at the end of which period the disease has become more or less stationary. The pathologic condition at this stage formulates the treatment. The hemorrhagic myelitis is subsiding, the perivascular infiltration which has blocked some of the spinal arteries is being absorbed, and these cells are resuming their function little by little, inflammatory products are being absorbed, and the clinical manifestation of these processes is expressed in what we all recognize as "spontaneous improvement," which begins when the tenderness disappears and lasts almost indefinitely, diminishing in its rate as the months pass.<sup>2</sup>

The clinical manifestation of the pathologic process is a motor impairment of muscles, widespread and in general erratic, more often a weakening than a complete paralysis. In the Vermont series of cases,<sup>3</sup> manual examination of muscles showed the proportion between partial and total paralysis to be as  $2\frac{1}{2}:1$ , and the more delicate muscle test,<sup>2</sup> which detects slighter grades of weakening, found the proportion to be as 9:1.

Our problem at this stage therefore is to restore the maximum function to affected muscles, and to study carefully the measures most likely to accomplish this end. This point of view becomes especially important when we realize that muscular weakening is much more common than complete loss of power. It is a very important matter to the patient with a gastrocnemius muscle with only 20 per cent. of the normal power whether that muscle ultimately regains 40 per cent. or 90 per cent. of its proper strength.

It becomes necessary then to consider those measures which are likely to prove most useful in bringing about the maximum improvement, and to comment on conditions likely to prove detrimental.

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2. Lovett, R. W., and Martin, E. G.: Certain Aspects of Infantile Paralysis, *THE JOURNAL A. M. A.*, March 4, 1916, p. 729.

3. Lovett, R. W.: The Treatment of Infantile Paralysis, *THE JOURNAL A. M. A.*, June 26, 1915, p. 2118.

**AMBULATORY TREATMENT**

When the acute stage is over it is on the whole desirable to get the patient on his feet, that is, to institute ambulatory treatment. Prolonged recumbency is for a child unnatural and undesirable physiologically and mentally. The sitting position not varied by the upright position is of all most likely to lead to flexion deformity of the hips and knees and to dropped feet. The upright position induced by ambulatory measures is desirable not only because it antagonizes the conditions mentioned, but because the effort to balance on the feet instinctively excites to effort a large number of muscles not otherwise to be reached, and is a valuable form of "muscle training," a therapeutic measure to be mentioned later. On the other hand, this method is open to the objection of possibly fatiguing convalescent muscles and some authors advocate prolonged recumbency. In my opinion, the ambulatory method with proper avoidance of fatigue is on the whole the best to be pursued at the end of two or three months.

If the patient can walk without braces, so much the better. If apparatus is needed to permit ambulatory treatment it should be used, but worn only in walking and in early cases not continuously. The most commonly required form of apparatus is the Thomas caliper splint, which serves to keep the knees straight. Crutches may or may not be required. A good general rule with regard to apparatus is that it should be used when the patient cannot stand without it, or if in standing or walking a position of deformity is assumed, because deformity leads to stretching of soft parts, and if persisted in to permanent bony changes.

The two conditions most frequently overlooked which lead to serious results are weakening or paralysis of the abdominal muscles and scoliosis. In the writer's opinion when these occur the use of a cloth corset or plaster jacket is imperative from the time that the first stage is over.

A patient who has been long in bed when first put on his feet is often unable to balance even if he has sufficient muscular strength, and the problem of cultivating equilibrium in these cases must be taken up by itself and patiently persisted in.

Having thus formulated the matter of ambulatory treatment, the question next arises as to those therapeutic measures which are likely directly to have a favorable effect on the muscles. These are (1) massage, (2) electricity, (3) heat, and (4) muscle training.

1. Massage is of value because it empties the veins and lymphatics and thus promotes the flow of blood to the limb, and because it apparently retards muscular atrophy and promotes muscular tone. More than this, however, is not to be expected of it. It does not promote the passage of nervous impulses from brain to muscle, and its action must be considered purely local. Given roughly or for too long a time it is detrimental and retards progress, and its overuse is probably responsible for much harm.

2. Electricity has been much discussed, and in the absence of definite data one must fall back on personal experience. Faradism causes a mild muscular contraction, and may be a useful form of gentle exercise. It is disagreeable, and to young children often a source of terror. The galvanic and newer forms of currents are assumed to have a beneficial effect in general, but in many years' experience in treatment with and without electricity (used often on one side of the patient only with the other side as a control) the writer has never been able to satisfy himself in a single case that it was of any value. Certain recent experimental work on the retardation of atrophy in denervated muscles is of interest:<sup>4</sup>

It is practically certain that if electrical stimulation has a beneficial effect, the optimal effect will be with that current which is strong enough just to cause contraction. In the ordinary methods of stimulating muscles through the skin, whether by unipolar or bipolar methods, with currents of long

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4. Langley and Kato: Jour. Physiol., 1915, xlix, 432.

or short duration, the intensity of the current is much greater in the superficial than in the deep fibers, and we think it doubtful whether the latter can be stimulated without using currents injurious to the former.

That the use of electricity has done much harm is undoubtedly, because not only is the use of strong currents admittedly injurious, but the routine use of electricity often deludes the physician and parents into thinking that the child is receiving adequate treatment while measures of admitted value are neglected.

3. Heat is of value either as radiant heat from electric bulbs or by some form of oven, because it raises the temperature of the limb, and thus offers more favorable conditions for muscular contraction, and because it stimulates the flow of blood to the limb.

4. Muscle training is in the writer's opinion the measure of the greatest value at this stage, and this stage is important because however operative the surgeon may be he will during these two years use nonoperative treatment.

Muscle training attempts to drive an impulse from brain to muscle to enable it if possible to open up new paths around affected centers in the cord. The connection between these centers with each other and between the centers and the muscles is most extensive and complex,<sup>5</sup> and the facts given as to the predominance of partial paralysis show that as a rule the entire nervous control of a given muscle is not wiped out as a whole, but only in part. On this basis rests the claim of muscle training, a measure which in the opinion of the writer is one of the most powerful factors in determining ultimate muscular function.

As to the efficacy of this treatment, the following data were observed in Vermont by means of the muscle test. The period covered was three months:

The chance of improvement in affected but not totally paralyzed muscles under expert treatment by muscle training

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5. Bing: Compendium of Regional Diagnosis in Affections of the Brain and Spinal Cord, New York, 1909.

was about 6 to 1, under supervised home exercises 3.5 to 1, under home exercises without supervision 2.8 to 1, while untreated affected muscles in these patients showed an improvement ratio of 1.9 to 1. These figures represent cases at the end of the first year. They are all from the Vermont group and were treated there.

In order to determine just what might be expected from the treatment by muscle training an analysis was made of the progress of all patients in my private practice during the past winter who had had two successive muscle tests at times widely enough separated to warrant any conclusions as to their progress. No cases were omitted, and the patients, as indicated in the accompanying table, are divided into two classes, those coming daily to the office for treatment by an expert assistant, and those whose treatment by muscle training was prescribed at the office but carried out at home by some unskilled person.

One difficulty presented itself in the analysis. Certain cases were regarded as having no power at all at the first examination, and in these cases for purposes of computing it was assumed that the children had power of one-eighth pound, not sufficient to move the scale. It was found that a child with one-fourth pound of muscle power would, however, move the scale, and these were the ones that were noted at the initial observation as having a trace of power. The percentage gain of each muscle was then reckoned, and the figure given in the table represents the average percentage of gain of all the muscles. If the paralysis was unilateral, the per cent. of gain in the unaffected limb was deducted from the gain of the affected side and only the excess counted.

Deformity occurs in many forms, but the therapeutics of it are easily formulated. In the earlier stages it is generally to be avoided by preventing persistent malposition. If fixed deformity exists it must be removed before undertaking treatment, nonoperative or operative. The neglect of this rule is one of the most frequent causes of failure of treatment. Defor-

mity is corrected by stretching by hand, by plaster or by apparatus, by forcible stretching under anesthesia, by tenotomy, fasciotomy, myotomy or osteotomy, the mildest measure that will suffice being the soundest and best.

Stretched muscles are at a great disadvantage so far as recovery goes, as pointed out years ago by Charles Fayette Taylor, and later by Robert Jones. The best example of this is in gastrocnemius paralysis, most efficiently treated when it exists alone by very high heels, throwing the muscle out of use and preventing stretching.

Fatigue and overtreatment by massage and exercises are detrimental factors of the highest importance too little attended to. This has been especially brought out by the studies by means of the muscle test, which have shown that a surprisingly small amount of exercise was detrimental to convalescent muscles, and in some muscles returning power has been wholly abolished by overuse. The advice often given to use affected limbs as much as possible is in the opinion of the writer the worst advice that can be given. It is difficult to underuse such muscles, but fatally easy to injure them by overuse.

3. The third stage is generally called the stationary stage, and begins about two years after the onset. The requirements of the preceding stage as to the care of the muscles, etc., still exist, but are less urgent. In cases which have not been properly treated earlier, muscle training may accomplish much, even in cases of long duration. The requirements as to apparatus remain much the same throughout.

The dominant requirements of this stage are operative, and are first the correction of deformity, a matter already discussed, and second, operations to improve function and secure stability.

Operations to improve function are by all experienced surgeons deferred until at least two years after the onset (and by some men several years) in order to

permit recovery of muscular power to become as great as possible and to enable the mechanical conditions in the affected limb to become clearly defined before operating.

## RESULT OF MUSCLE TRAINING

Age	Time Since Attack	Interval Covered by Tests	Average Total Gain of Affected Muscles, per Cent.	Average Monthly Gain of Affected Muscles, per Cent.	Apparatus Worn	Region Recorded
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Patients treated daily at office by skilled assistants

22	1 mo.	6 mos.	197	24	Sling.....	Arms
8	8 mos.	5 mos.	82	16	Corset, crutches, braces	Legs
9	3 mos.	6 mos.	146	21	None.....	Legs
9	21 mos.	10 mos.	200	20	Plaster jacket, crutches, braces	Legs
14	4 mos.	4 mos.	688	172	Corset, braces, crutches	Legs
8	15 mos.	7 mos.	702	100	Corset, braces, crutches	Legs
8	8 mos.	6 mos.	184	80	Corset.....	Legs

Patients treated at home by relatives or nurses (unskilled)

10	1 yr.	6 mos.	13	2	High heels.....	1 leg
80	5 mos.	1 mo.	44	44	Sling.....	1 arm
24	6 yrs.	3 mos.	12	4	None.....	1 leg
10	2 $\frac{1}{4}$ yrs.	8 mos.	108	18.5	Corset, plate....	1 leg
11	6 yrs.	5 mos.	89	17	Plaster jacket, braces	Legs
4	1 yr.	7 mos.	30	4	Brace.....	1 leg
11	9 yrs.	2 mos.	33	17	None.....	Arm and leg
10	8 yrs.	4 mos.	16	8.5	High heel.....	1 leg
10	5 yrs.	7 mos.	None	None	High heel.....	1 leg
14	8 yrs.	8 mos.	67	8	Plaster jacket, brace	1 leg
16	2 mos.	8 mos.	620	206	Brace and crutches	1 leg
8	1 yr.	7 mos.	202	28	Braces and corset	2 legs, 2 arms

Tendon transplantation<sup>6</sup> is the most brilliant of these measures. It implies the existence of one comparatively normal muscle in the region to be operated on. Simple operations have replaced complicated ones,

6. Lange: München. med. Wchnschr., 1902, No. 1; Ztschr. f. orthop. Chir., xxix; Ztschr. f. ärztl. Fortbild., 1905, 22. Vulpius: Deutsch. med. Wchnschr., 1912, xxxvi. Lovett: Boston Med. and Surg. Jour., 1910.

periosteal insertion is used, silk extensions are in common use, tendons are passed in the subcutaneous tissue, and prolonged after-treatment is the rule, unrestricted use not being allowed under one year from operation.

Nerve transplantation,<sup>7</sup> which is the other operation to improve function, has not been generally used because the most skilful operators in this field have not reported a large proportion of satisfactory results, and also for the reason that the operation is advised at so early a period in the disease.

#### OPERATIONS TO IMPROVE FUNCTION

Arthrodesis<sup>8</sup> has lost favor because of the entrance in the field of operations yielding better functional results, and the most experienced surgeons do not favor it in the ankle until after late childhood, if at all. At the knee it is always questionable and dangerous in early childhood. In the hip it is desirable, but often unsuccessful.

Astragalectomy,<sup>9</sup> on the other hand, has gained in favor, and although originally introduced by Whitman only for talipes calcaneus, it is now widely used where arthrodesis would formerly have been performed. A transverse section of the foot devised by Davis<sup>10</sup> deserves mention as being useful in calcaneus deformity.

Silk ligaments<sup>11</sup> are used because silk left in the tissues becomes coated with fibrous tissue and serves as a ligament. This is especially used to correct the dropped foot by passing several strands of silk anteriorly from the tibia to the tarsus. It is a brilliant operation when successful, but has often failed, probably because too little silk has been used. In a

7. Spitz: *Handbuch der Kinderheilkunde*, Lange and Spitz, Leipzig, 1910, p. 310; *Ztschr. f. orthop. Chir.*, xiii. Osgood (review): *Boston Med. and Surg. Jour.*, June 30, 1910. Vernicchi: *Arch. di ortop.*, 1910, xxvii, 337. Kilvington: *Brit. Med. Jour.*, April, 1907. Deroux: *Lyon chir.*, December, 1912.

8. Jones, Robert: *Tr. Int. Cong. Surg.*, 1909, xvi.

9. Whitman, R.: *Ann. Surgery*, February, 1908; *Am. Jour. Med. Sc.*, November, 1901.

10. Davis, G. G.: *Am. Jour. Orthop. Surg.*, October, 1913, p. 240.

11. Lange: *München. med. Wochenschr.*, 1906, li; *Ztschr. f. orthop. Chir.*, xvii, 266.

child of 8 or 10 one should use six to eight strands of No. 12 silk.

Tendon fixation<sup>12</sup> or tenodesis has lately been revived by Gallie, and is extensively used. The paralyzed tendons are sewed into grooves in the bone, thus being transformed into ligaments, to correct deformity and check excess of motion. Stretching may occur, but the operation seems to have a field of usefulness.

Two of these operations are frequently combined, as, for example, tendon transference and silk ligaments, and similar instances.

#### SUMMARY

This paper is a plea for a definite uniform plan for the treatment of infantile paralysis in all of its stages, for a direct attack on the disease based on its pathology, and for persistency and precision in that therapeutic attack, with special care as to the avoidance of fatigue from overexercise or overtreatment. It is the belief of the author that nowhere in orthopedic surgery does the difference between the best and indifferent treatment have more effect on the ultimate result than in this disease.

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#### ABSTRACT OF DISCUSSION

DR. E. W. RYERSON, Chicago: There is no question about the value of the muscle training as advised and perfected by Dr. Lovett. It is, however, unfortunate that so desirable and important a method of treatment should be so difficult to apply in most of our large clinics. It is not so difficult in private practice, where we have specially trained and paid assistants; but it is very hard to obtain voluntary service in our free clinics. For that reason, in my experience, this method of treatment has been very much neglected. The use of electricity has been, very properly, frowned on by the author. His experience corresponds exactly with my own. While electricity will always assume a certain position in these cases, because we hope that it may do some good, I know of no one who has done much practical work

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12. Gallie: Am. Jour. Orthop. Surg., January, 1916.

in this line who will enthusiastically claim very much value from its use.

The operative treatment, as described by Dr. Lovett, is of great importance; for the reason that we shall always be confronted with a large number of cases in which no other method of treatment has been used, or perhaps could be used. I formerly advocated the use of silk in the form of ligaments and tendons. During the last few years, however, I have not been so confident that this was the ideal method of treatment; for the reason that there is a certain element of uncertainty in the use of silk. I have seen cases in which the silk acted as a foreign body—perhaps very long after the operation—and had to be removed, and in which the fibrous tissue that had been deposited around the silk was apparently not strong enough to do the work that we had expected the silk to do. Hence, we are inclining toward tendon operations and fixation, especially in the line of astragalectomy. This, in the field of marked deformity, will always be the routine treatment, combined with tendon fixation and tendon transplantation.

DR. H. W. FRAVENTHAL, New York: Some years ago. I started an orthopedic clinic in New York in which I treated bad cases of infantile paralysis of more than three years' duration. Many men are not sufficiently familiar with what massage and electricity can do, when you do not overdo it. In the last year, I have had as patients a number of adults who had been troubled for more than ten years, and I hope to show the result at the next meeting of this section.

DR. F. C. KIDNER, Detroit: I, too, was very enthusiastic about silk ligaments three years ago, but I became less enthusiastic as time went on. I still believe, however, that they have a very useful application as a help or a steadyng factor, for a few months, in connection with massage, electricity and other forms of treatment; but I do not believe that they hold very strongly.

DR. A. H. FREIBERG, Cincinnati: In reference to tendon fixation, we should go slowly. The lesson that we should have learned in connection with our experience with silk ligaments is that caution should be observed in selecting this method of treatment. The gentlemen who have just spoken have referred in the past to the very definite value of silk ligaments, and are now retracting these statements. I wish to confirm what Dr. Lovett said about the use of massage and electricity. Every doctor who buys an electric battery tries electricity; but I am convinced that electricity, in itself, is an agent of no value in bringing about recovery or even considerable improvement in these cases. On the other hand, I am convinced that massage is of value: but I am also convinced that its value is not to be compared

with that of muscle training. The latter, however, has to be administered properly to be of benefit; and this demands experience.

DR. F. J. GAENSELEN, Milwaukee: I have done a number of cases of silk-ligament suspension, and in two of them there occurred a fracture of the tibia at the point of insertion of the ligament. In one case, the silk had torn; and a subsequent silk ligament suspension was done, a long time after the first. At the second operation, the drill-hole was placed a short distance above the first hole; but, following a slight trauma, a fracture occurred near the point of insertion. The roentgenogram seemed to show osteoporosis about the point. In another case in which there had been only one drill hole, the fracture also occurred at that point. I suppose that osteoporosis was responsible for it, and wonder whether others may not have had the same experience.

DR. A. L. FISHER, San Francisco: Three years ago I had the same feeling in regard to the value of electricity as those who have spoken, but I have since seen the results secured by a man who had paid great attention to this method of treatment in Paris. He uses a very weak interrupted galvanic current. This does not seem to be important; yet in the two groups, treated prior and subsequent to three years ago, there is a contrast that shows that there is great benefit from this method of treatment. Another, and more important method of electric treatment to use is the faradic current. By it, you can get an idea of the quantitative amount of the muscle strength, by using a given coil and getting the minimum amount of current that will elicit a response to the unaffected side and treating the affected side, using the same amount of current. The proportion of muscle damage is practically in inverse proportion to the amount of current that it takes to get a response. This, in the way of prognosis, is extremely important.

DR. J. T. WATKINS, San Francisco: I have not had any success at all with the use of galvanism and faradism. With regard to muscle building, people living in the South and other distant parts of the country cannot go to New York for this training; so the work has to be turned over to persons who are sometimes expert, and sometimes not. My experience is that the people who had been trained in Christiania or London, when dealing with very young children, got practically no results from muscle building. They did not seem to be able to convey to the children what was needed, so that they could do it themselves by mental impulses. On the other hand, when dealing with older persons or adults, they obtained very remarkable results.

DR. WALTER G. STERN, Cleveland: Believing as I do in the value of massage and muscle training and also that

overuse and overstimulation of the weakened muscles are especially harmful, I hold that Dr. Lovett is incorrect in his advice to us and through us to the general practitioner "to put the patient on his feet as soon as the acute symptoms have subsided," because when you allow this you allow him to run the dangers of overuse and overexertion. The patient makes his own efforts at walking, is stimulated by his parents to make further efforts and by the neighbors and friends to make still further attempts. These efforts are all made through the contracture of the strong and healthy muscles, which increase in proportionate strength to such an extent that soon overstretching of the weakened muscles takes place and they lose their tone. This is one of the chief causes of deformity which we find so difficult to overcome later on. Children should have, at least, a considerable period of rest after the acute stage, and during this time one can use muscle training and massage to good advantage. The late Dr. Townsend told us a few years ago that his best results in the first epidemic in New York were obtained with children who had been kept in bed for at least a year; Judson says eighteen months to two years, but that seems to me to be entirely out of the question. However, I believe that they should be kept quiet for a much longer period than Dr. Lovett would have us infer from his printed statements.

**DR. W. R. MACAUSLAND, Boston:** I agree thoroughly with Dr. Lovett's outline of conservative treatment, but I object strenuously to a statement made by him that the results of tendon transplantation and silk ligament fixation are "brilliant." These infantile cases demand stability and increased function. I have seen silk ligaments that have produced deformities by holding too strongly or insecurely, and an endless number of tendon transplantations that have not held, so that the part was weaker than before the operation and the patient was distinctly hurt by the tendon transplantation. I feel that, with the exception of about one transplantation in the foot, there is but one operation to be done in these cases of infantile paralysis that can stand the test of time; and that is astragalectomy, as outlined by Dr. Whitman.

**DR. CHARLES A. PARKER, Chicago:** I believe that every man does the best work in his own hobby. If he believes in operations, he gets the best results with them; if he believes in the use of electricity, or in massage, or in a combination of the two, he gets the best results with them. Most of the deformities are in the lower extremities in infantile paralysis, and the best result that we generally get, after the patients have lost the finer movements, is to teach them to stand on and use their feet and legs for the support of their body. In considering these different operations, one

sometimes loses sight of the fact that the body should be straight, in order to be stable. The body should be straight over the hips, the knees straight, and the feet at right angles. These three conditions are the factors leading to the best results. How to get them is answered differently by different men. Some prefer tendon transplantation; some, astragalectomy, and some, other means.

DR. FRANK E. PECKHAM, Providence, R. I.: What do we want to obtain by our treatment? I may be wrong; but, personally, I feel that I want a fresh influx of blood to the paralyzed muscle. How is that best obtained? It has been held as an opinion that we could not do much until the pain stage had passed; but I have found that I could begin treatment in the acute stage just as soon as I could have the child brought to the office. I have begun even before the fever had subsided entirely. You commence immediately by treating with applications of heat. I use a five hundred candle-power electric lamp for twenty minutes, and I apply mechanical stimulation by vibration. There is no pain caused by the treatment, and there is entire relief from pain in five minutes after the treatment is started. The relief lasts for a while only; repetition of the treatment, however, makes it permanent. I find that the cases improve faster in that way than when this method is not followed.

In regard to electricity: There are so many ways in which electricity may be applied that it is not fair to say that electricity is of no value without specifying just what method of application is meant, any more than it would be to state that drugs are useless without mentioning which drugs are referred to. The use of electricity is understood by the general practitioner to produce muscle contractions. Personally, I have not done that with it. I think that electricity has a use, but we must decide just what we want to accomplish and then accomplish it. The whole process should be stated in absolutely definite terms.

DR. ROLAND MEISENBACH, Buffalo: I wish to lay stress on the value of apparatus in connection with cases of infantile paralysis, even in the earliest stage. By a careful adjustment of the proper apparatus, one can assist muscles to return to their normal more quickly than without. However, before the apparatus is applied, we must keep in mind the actual condition of the muscle, not only at the time when the apparatus is applied, but in the course of the paralyzed or paretic muscles. The opposite can also be said about apparatus that is applied without any understanding of the muscle action. I have seen an entire quadriceps regenerated in a child, and I know it was due to the fact that a duralumin brace had been applied properly and so regulated from time to time as the muscles became stronger that the opposing group of muscles had no opportunity to

check the progress of the quadriceps. Therefore, one should not apply apparatus unless he has a very thorough understanding of the individual muscular action. Dr. Lovett said that operation should be postponed until the third stage. I believe it is true. I think it is wrong to operate in the early stage. The insertion of silk is not the proper method of treating infantile paralysis, for two reasons: First, because it is not permanent; second, because it may check muscle exercise, and therefore prevent regeneration of one or a group of muscles. There is no question that silk resolves. If any one of you has had an opportunity to study cross sections of silk strands embedded in living tissue, you will see that after twenty days there is very little silk left, and in its place is connective tissue. I am taking out many more silk ligaments than I am putting in.

I firmly believe that apparatus, if applied carefully with Dr. Lovett's idea of muscle education in mind, will give better results. Stability is to be desired. You cannot immediately get stability by operative procedure. Where the attack of infantile paralysis is very mild, I have applied rubber muscles, as I chose to call them. These could be adjusted in thickness and width corresponding to the afflicted muscles, whether they were in a state of paresis or total paralysis. These acted as apparatus, and were sometimes combined with apparatus, especially in the early stage of infantile paralysis. The rubber tissue over the involved muscle acted also by causing a hyperemia, and thereby stimulating circulation. I cannot agree with Dr. Lovett in his statement that the pathology of infantile paralysis changes so rapidly for the better. I would like to ask Dr. Lovett whether the afferent and efferent impulses have much to do with the rapid rebound in cases of infantile paralysis, and whether he can tell the percentage of gain in the given paralyzed muscle in, let us say, six months of paralysis.

DR. ROBERT W. LOVETT, Boston: I do not want to go on record as advocating extreme conservatism in the treatment of the disease. If we can avoid operation, so much the better. Dr. Stern's criticism about getting the patients on their feet is a just one. I intended to protest against allowing children to sit in a chair, month after month, and did not mean to imply that there should not be considerable rest. In many cases, I do not allow walking at all. I am satisfied that the element of fatigue is of great importance in all early cases, and I am getting better results since I have been paying greater attention to it. I did not mean to advocate the insertion of silk ligaments over the other operative measures, but only as one of the operative procedures. I have had failures in cases in which I have used it. I now put in from six to eight strands of No. 12 silk. I do not know how this will work out in the end. I hold no brief for it over astragalectomy. It often has failed, but

its results have often been brilliant. The muscle test gives a quantitative test of muscle strength. I believe it to be reliable. I have been able to treat the cases better, because I could take tests of them in that way. I believe that it is the means by which the question of the benefit of electricity can be settled. I am starting on the observation of a set of cases treated with and without electricity in order to compare the two sets by quantitative tests. Nine patients out of ten in my private practice during the last winter have had their muscle training under the mother or an untrained nurse. The results under these circumstances were about one third as good as when given in my office by an expert.

I must differ with Dr. MacAusland about tendon transplantation. I think it is a very good and at times a brilliant operation, although there are failures from its use; but the same may be said of astragalectomy. I think that astragalectomy is suitable for one set of cases, while tendon transplantation is suitable for another set. Tendon transplantation is especially suitable for cases in which you have tested the muscles and know just what you are doing. Of course, if you substitute a very small muscle for one that is strong and heavy there is nothing in it; but if you test out the muscles beforehand, you can avoid this. Therefore, this muscle test is in the line of precision. It has shown me how little I knew about the disease. Dr. Meisenbach's questions I cannot answer. The tendency of my paper is not to advocate any particular method. I merely wished to state my personal experience and to make a plea for a greater precision in the treatment, advocating a plan based on the supposition that there will be two years of nonoperative treatment. What operative treatment we should employ is a separate question.

## CALCIFIED HEMATOMA

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FREDERICK C. KIDNER, M.D.  
Fellow of the American College of Surgeons  
DETROIT

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Interest in the occasional development of bone masses in and beneath muscle following trauma has been great, especially since the Roentgen ray has made possible their clear demonstration. The condition has commonly gone under the name of myositis ossificans traumatica, because it has been believed that damaged muscle is actually changed into bone. Other names have been suggested depending on various theories of origin; for example, calcified hematoma, based on the theory that the blood clot following an injury becomes calcified, and periosteal callus, on the theory that the growth is merely misdirected callus formation. The best known theories so far put forward are, first, the hemic theory (Sadeler). This theory supposes that the hemorrhage following an injury to muscle is first transformed into cartilage which later ossifies. Second, that the tumors are aberrant sesamoid bones (Bard). Third, the theory that the growths result from bits of periosteum detached and included in the muscle. Fourth, that the fibrous tissue of the muscle undergoes a true metaplasia into bone. Fifth, that the bone develops from cells disseminated from the periosteum through the hemorrhage. All these theories have warm supporters and antagonists.

The best discussion which has come to my attention of the surgical and pathologic aspects of this condition is that published by Fay.<sup>1</sup> He favors the combination

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1. Fay, O. J.: Parosteal Callus, the So-Called Myositis Ossificans Traumatica, Tr. West. Surg. Assn., 1913, p. 174.

theory in which both the periosteum and the fibrous tissue of the muscles take part.

Much of the confusion as to the origin of these growths is due to the fact that sometimes the bone mass is attached to the periosteum, and that sometimes it lies within the muscles without periosteal connection, most commonly in the brachialis anticus or the quadriceps. This difficulty is easily overcome by the assumption, which I believe to be a reasonable one, that there is always, at some time, a direct connection with periosteum which may or may not be absorbed or broken off by muscular action. In support of this assumption is Coley's<sup>2</sup> statement that recurrence can best be avoided by covering the periosteum with a fascial graft.

The following case aroused my interest in the subject, and is, I believe, worth reporting in the hope of shedding a little more light on the causation of the condition:

W. B., vigorous schoolboy, aged 16, was without disease or family taint. Five weeks before he was seen, March 21, 1916, he was kicked on the front of the thigh during a basketball game. There was immediate pain and stiffness, but he continued the game. Next day pain was rather severe and he was forced to limp. Pain gradually passed off but the stiffness did not decrease, and for the past two weeks had been increasing. Examination showed a slightly tender, hard mass involving the middle third of the front of the thigh. The muscles moved over it to a certain extent, but flexion of the knee was possible to only about 15 degrees, a severe pulling sensation preventing further motion. Probable diagnosis of calcified hematoma was made. Roentgenograms taken at the time showed a long mass, with the character of bone, lying close to the front of the femur, to which it was attached at one point.

The possibility that the mass was sarcomatous made exploratory operation advisable. This was done, March 22. An incision, just in front of the iliotibial band, at the outer side of the growth, was carried through the fascia lata, and the muscles separated by blunt dissection. A mass of vascular new bone was found, surrounding the anterior half of the middle third of the femur. Anteriorly it was firmly adherent

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2. Coley, W. B.: Myositis Ossificans Traumatica, Ann. Surg., lvii, 305.

to the vastus medius by many torn and partially destroyed muscle fibers which issued from the bone substance. These anterior attachments were easily separated and the bone found to be firmly adherent, at about its middle, to the surface of the femur. With considerable difficulty the mass was pried loose and removed. At the point of adhesion to the femur was found an area one-half inch in diameter, where the bone was denuded of periosteum. The perimeter of this denuded area was made up of much thickened and edematous vascular periosteum with ragged edges. The thickening gradually decreased in all directions for a distance of three-quarters inch, at which point the periosteum became normal.

Feeling convinced that the mass originated from the periosteum at this point, the denuded area and the edges of the thickened periosteum were carefully covered with bone wax in the hope of preventing further overgrowth. The specimen was sent to Dr. C. R. Meloy of Grace Hospital, to whom I am indebted for the microscopic slides. The patient made an uneventful operative recovery and was about in ten days. Two weeks later he had about 45 degrees of motion in the knee, and was rapidly gaining more motion. At that time, he sustained a severe wrench, whereupon the stiffness promptly reappeared, and there was very marked induration of the deep tissues of the front of the thigh, which closely resembled the original growth. Since, this has gradually disappeared and motion is constantly increasing. The roentgenograms taken at present show that the growth has been stopped and that the remains of it are absorbing. The microscopic sections taken from various parts of the new bone are of extreme interest, in that they show all stages of bone formation. The whole mass is surrounded by a fibrous tissue capsule, in the meshes of which can be seen partially destroyed muscle fibers. These are scattered all through the growth. From this capsule, cartilage is growing, as is bone. There are areas of transformation of cartilage into bone, and areas of fibrous tissue undergoing myxomatous change with a substitution of cartilage cells, evidently a direct change in cell character. The picture, therefore, is that of callus formation originating in the periosteum. Everywhere the picture is that of muscle destroyed by an invading growth, rather than muscle changing into bone. The muscle bundles are evidently infiltrated and destroyed, not actually forming new tissue.

Clinically this case is an example of successful operation for the removal of a large and necessarily disabling bone growth. The failure to recur I believe to be largely dependent on the use of the protective film of bone wax at the point of periosteal injury.

Pathologically I believe the course of events to have been something as follows: The original traumatism tore deep muscle fibers, and at the same time caused a break in the periosteum. From both sources blood was poured out, and immediately deeper layers of periosteum responded to the stimulus of trauma by pouring forth osteoblasts. These were free to wander through the mass of hemorrhage, which, in this case, occupied only the deepest layers of muscle tissue. A delimiting fibrous tissue membrane was formed by the intramuscular fibrous tissue as a preparatory step to the absorption of the blood clot. On this membrane and its meshes were deposited the free bone-forming cells, and from all directions bone growths began. Had the hemorrhage lain deeper in the body of the muscle or had the tear in the periosteum been smaller, it is easy to see how the connection between the two might have been obliterated within a very short time, and the bone growth have become entirely enclosed within the muscle body. Had this occurred, Roentgen rays would have at no time shown connection between the growth and the periosteum, because the connection would have been severed before sufficient calcium was deposited to throw a shadow.

Although I realize that the evidence of this case is far from conclusive, its presentation is justified on two grounds, first, because the apparent course of events is so plain and easy to understand, and second, because the theory which it seems to substantiate is a simple one. Metaplasia of one tissue into another, even under extraordinary stimuli, is a difficult conception. Over-production of the tissue from its usual source is a simple one.

David Whitney Building.

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#### ABSTRACT OF DISCUSSION

DR. W. C. CAMPBELL, Memphis: I have had two similar cases, both of which were infected. The first case occurred in a young boy, nine years of age, who was referred to me for tuberculosis of the hip. The roentgenograms showed a ring of bone in the region of the lesser trochanter. Stereoscopic roentgenograms showed this ring of dense bone, about the size of half a dollar, to be posterior and slightly external to the lesser trochanter, and not connected with it in any way. There was a sinus running from just below the greater trochanter tortuously through the thigh at the level of the lesser trochanter, opening internally in the perineum. Bismuth injection of the sinus brought it out quite clearly. I found at operation that there was no connection whatever with the bone. There was no erosion, and the periosteum was intact; but the condition was of two years' duration, and had followed an injury. The result was complete cure, with no recurrence after two years. The second case was that of a man of thirty, who gave no history of injury. This case was also referred with an erroneous diagnosis of tuberculous knee. The knee was red and fluctuating. Operation showed an irregular mass anterior to the femur, just above the knee joint. The mass was easily removed, and the patient made an uneventful recovery, except that the knee was involved and required further work. Microscopically the mass removed was bone and not calcium deposits as frequently occur in suppurating areas. These cases were interesting, because both were infected, one with a sinus, and the other having no sinus.

DR. JAMES T. WATKINS, San Francisco: I operated on a youth of sixteen who, while playing football, had received a kick on the external aspect of the lower end of the thigh. He was not more than temporarily discommoded, but later

**Fig. 1.—Before operation.**

Fig. 2.—Present time

**Fig. 3—Cartilage formation.**

**Fig. 4.—**Muscle surrounded by bone and fibrous tissue growth.

**Fig. 5.—**Bone growing from capsule



noticed at the site of injury a lump which was painless, but gradually increasing in size. He wanted to enter the Naval Academy, but had been told that this deformation would exclude him. For this reason he wished it removed. So I cut down on the femur and chipped the mass off. The muscle was not particularly adherent to it. It did not occur to me to cover the cut surfaces as Dr. Kidner did so as to prevent a recurrence. However, there was no recurrence. Macroscopically it looked more like cartilage than bone. The pathologist reported it to be a mixed cartilage and bone tumor and of a benign nature.

DR. J. D. GRIFFITH, Kansas City: These growths occur not only connected with those parts of the body where bones or periosteum are, but also elsewhere. On two different occasions I have taken such a growth out of the abdominal muscles. These specimens gave the evidence of bone structure. My cases seem to show that in all instances the growth is not periosteal.

DR. FREDERICK C. KIDNER, Detroit: In regard to the question of origin of the bone in these unusual growths, I would say that I limited my paper to the purely traumatic cases following on severe injuries. Such cases as Dr. Campbell mentioned are very often the result of an infection, and the masses consist of calcium deposits, rather than bone. I should like to know whether the masses were examined in Dr. Campbell's cases.

DR. CAMPBELL: Yes. They were both necrotic bone, and the condition followed injury in one instance.

DR. KIDNER: The element of chronic infection and of irritation enters here, and it is easy to conceive that the periosteum might be healed after the bone mass was formed. In regard to the masses in other places, where there is no bone near, I do not think that we know much about them. I am not willing to advance any theory on that subject.

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ASTRAGALECTOMY (WHITMAN OPERA-  
TION) IN INFANTILE PARALYSIS

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It is not my object to discuss more than in a general way the various operative procedures in the paralyzed foot, but rather to emphasize the value of an operation which has stood the test of time; and unlike tendon transplantation, silk ligaments, etc., has been found practical, efficient and permanent in combating the instability so frequently seen in the paralyzed foot. It seems to the writer that except for one or two possible conditions in the paralyzed foot, transplantation should be discarded in favor of a procedure giving permanent results in the hands of the surgeon. As one compares the results in a series of cases some years after operation, it seems quite remarkable that transplantation of tendons and the use of silk ligaments still persist.

Infantile paralysis most frequently leaves its mark in the muscles of the foot where varying degrees of paralysis persist from a mild weakness of one group or a paralysis of one group to a total paralysis of the entire muscle strength below the knee. The extent of the disability, however, only rarely coincides with the extent of the paralysis.

Weakness, instability of the foot and deformities follow paralysis of one group as frequently as they follow paralysis of all the muscles. It is the failure to recognize this fact that tempts the surgeon to use such insufficient means as transplantation and silk ligaments in order to combat deformity in those cases with slight loss of muscle power. The normal foot is balanced by

muscles working in perfect coordination, assisted by ligaments which check extremes of motion. To expect sufficient restoration of balance following transplantation is illogical from a mechanical and physiologic point of view, and in the experience of the writer not based on careful and prolonged clinical observation.

Our first duty, of course, is to foresee and prevent structural deformity, thereby favoring regeneration and recovery of power.

If this recovery does not take place, then we arrive at the point where operative interference must be considered or the patient condemned to a brace for permanent support. Here the question arises as to the class of cases in which surgical interference is indicated. We must all believe that operative interference should be delayed as long as there is a possibility of a return of power, e. g., about one and a half to two years following initial attack. In children, where deformity may usually be prevented, my experience leads me to wait longer if the age of 6 or 7 has not been reached. In the presence of deformity not easily correctable by manipulation, this age limit may be lowered a year to hasten good locomotion.

What operation shall we choose? During the past six years I have used astragalectomy as devised by Dr. Royal Whitman<sup>1</sup> in almost all of the deficiencies following infantile paralysis affecting the leg. Altogether my series comprises 135 cases, a sufficient number to warrant the formation of definite opinions concerning its value as an operation. In short, I may state that it has come to replace the commoner operations of transplantation, silk ligaments and allied operations. Astragalectomy gives stability, which is not in my experience obtained by the other procedures, and in addition preserves sufficient motion for good function of the ankle. Arthrodesis when successful stiffens the joint and an awkward gait results.

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1. Whitman: Am. Jour. Med. Sc., 1901, cxxii, 593; Am. Jour. Orthop. Surg., 1910-1911, xiii, 137; Am. Surg., 1911, liv, 860.

*Age.*—Astragalectomy can be done at any age following a period of two years after the original paralysis, but if possible should be reserved until the child is 6 or 8 years old. If, however, deformity is not being prevented by apparatus and if the limp is more than the extent of the paralysis warrants, then I should not wait for this age; for atrophy and shortening go hand in hand with the severity of the deformity and the limp, not with the extent of the paralysis. In the period between 6 and 16 years of age the most satisfactory results are obtainable. We have done the operation later but find that more sensitiveness and pain are liable to follow, and the results, in spite of good stability, motion and a good posture, are not quite as satisfactory as when done early.

*Indications.*—The conditions in the foot for which this operation may be done with benefit are many. Probably the most striking results follow its use in the deformity of calcaneovalgus, for which it was originally planned (Fig. 1). Here with the shifting of the tibial weight forward, and the transplantation of the peronei into the Achilles, a most striking functional result is obtained. But its use cannot be limited to this alone. It gives excellent and standard results in all foot conditions—even where only one muscle is paralyzed.

*Operative Technic* (Figs. 2-10).—Here as in other joint operations the asepsis should be guarded carefully and manipulation should be gentle. A curved or L-shaped incision is made around the external malleolus, tending forward over the head of the astragalus. The upper flap is then dissected upward, exposing the tendons of the peroneus longus and brevis, which are then dissected free and severed just at the fibular tip. The ends are caught in No. 2 catgut sutures and retracted.

An incision is then made through the external ligaments around the astragalus, using especial care about

**Fig. 1.—Three of the more common deformities in the partly paralyzed foot.**

**Fig. 2.—Astragalectomy — the Whitman operation: On left, line of incision. On right, tendon of peroneus longus exposed; tendon of peroneus brevis being exposed.**

**Fig. 3.—Astragalectomy — the Whitman operation: On left, peroneal tendons sutured and divided. On right, external lateral ligament divided; tibioastragaloïd ligament divided; interosseous and external talocalcaneal ligaments being divided.**

**Fig. 4.—Astragalectomy — the Whitman operation:** On left, dislocation of astragalus by strong inversion of foot. Note heavy dissector under neck by which astragalus is pried loose head first. On right, widening tibia-fibular articulation by removal of thin slice of cartilage from internal malleolus.

**Fig. 5.—Astragalectomy — the Whitman operation:** On left, widening the tibia-fibula articulation by removal of thin slice of cartilage from one or both; the internal lateral ligament has been dissected up to sharpen the malleolus. On right, the new articulation for internal malleolus. Note removal of inner one fourth to one sixth from inner side of scaphoid, thus forming pocket for sharpened internal malleolus.

**Fig. 6.—Astragalectomy — the Whitman operation:** On left, the external malleolus rests in a similar socket over calcaneocuboid joint. Note backward displacement of foot, and fibula carried well forward. On right, above, normal relation of tarsal bones; below, relations following the properly done astragalectomy.



**Fig. 7.—Astragalectomy — the Whitman operation:** Disposition of tendons of peronei into the Achilles tendon and resuture, and tendon fixation (Gallie operation).



**Fig. 8.—Astragalectomy — the Whitman operation:** Disposition of tendons of peronei, into Achilles tendon, and resuture of ends.



Fig. 9.—Astragalectomy — the Whitman operation: Note the posterior displacement and the position in which the foot is being held during suture and the application of plaster with the knee flexed and the foot in slight equinovarus.

Fig. 10.—Astragalectomy — the Whitman operation: In plaster, following operation.



Fig. 11.—Shoes to be worn after Whitman astragalectomy

**Fig. 12.—**Infantile paralysis, valgus deformity. From left to right, anterior view before operation, lateral view before operation, anterior view twenty months after astragalectomy, and lateral view twenty-two months after astragalectomy.

**Fig. 13—**Infantile paralysis, calcaneovalgus deformity: Anterior view before operation, lateral view before operation, and lateral view twenty months after astragalectomy (Whitman).

**Fig. 14.—**Infantile paralysis, calcaneovalgus deformity, operation, May, 1912: Anterior view before operation, posterior view before operation, anterior view six months after astragalectomy (Whitman), posterior view six months after operation, and lateral view six months after operation.



the head of the astragalus. The foot is strongly inverted. Then by placing a blunt dissector under the neck of the astragalus, the bone is pried out of position head first, and removed. At once the ease of displacing the foot backward will be noticed, but in order to insure a good joint a certain amount of modeling must be done.

The internal lateral ligament is dissected upward from the internal malleolus; if necessary, a strip of cartilage is removed from both tips to span the scaphoid and cuboid; a small piece is excised from the side of the scaphoid and cuboid to form pockets for the malleoli. The foot is then displaced backward and held carefully in this position to insure the proper relations in the new joint. A moderate equinovalgus gives stability while holding. The peronei are disposed of by suture to the Achilles tendon, by tendon fixation or by resuture to the distal ends of the tendons of the peronei, as indicated in the given case. The skin is closed with catgut and plaster applied from the toes to midthigh with the knee flexed and the position of foot in equinovalgus. The leg is kept elevated for a period of ten days, after which crutches may be used. The first change of cast takes place in three or four weeks, at which time the equinus is corrected to a right angle in cases of quadriceps paralysis or left in 5 to 8 degrees equinus where the quadriceps is present. Valgus should persist throughout the treatment.

A leather shoe (Fig. 11) is then put over the plaster and the child allowed to walk, changing the plaster as necessary for five to six months. Following its removal a shoe with a lift on the outer side of sole is used. One half or three-quarter inch cork lift under the heel will compensate for shortening of leg and improve the gait. Circulation improves rapidly with the return of good function and loss of growth ceases, the paralyzed leg beginning to grow at a rate equal to that of the well side.

*Conclusion.*—The results obtained with astragalec-tomy have led me to discard, except in the rare cases, all other procedures.

#### LITERATURE

Various methods for remedying the condition have been devised. Amputation of the foot in cases of severe deformity is advocated by Watson.<sup>2</sup> I know of no other report on this operation. Lange's silk ligaments are advocated by many authors, among whom are Allison,<sup>3</sup> Bradford,<sup>4</sup> Barton and Plummer,<sup>5</sup> and Lovett.<sup>6</sup> Rich<sup>7</sup> says that they are of use in joints where there is no external irritation, as there is in the ankles from shoes. Here he advocates capsule tucking. Nerve grafting is advocated by Spizzi and others. The general opinion has been summed up by Feiss,<sup>8</sup> who says there is no experimental evidence to justify its use in paralytic cases. Tendon transplantation has its chief advocate in Vulpian.<sup>9</sup> Soule<sup>10</sup> advocates arthrodesis of the astragaloscaphoid joint, with the use of a bone peg to aid ankylosis.

The operation of astragalectomy was first performed in 1842 by Lund<sup>11</sup> of London for the correction of a very severe talipes, and its use has since been reported by numerous authors usually in traumatic and infectious cases. Willens<sup>12</sup> reports in 1911 its use in cases of clubfoot in an operation devised by him. Peraire<sup>13</sup> used it with goods results in a case of traumatic paralytic equinovarus. In none of these was the foot displaced backward. Its use in paralytic talipes was first advocated by Dr. Whitman in 1901. The

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- 2. Watson: Brit. Jour. Surg., 1914-1915, p. 390.
  - 3. Allison: Am. Jour. Orthop. Surg., 1912-1913, p. 519.
  - 4. Bradford and Soulter: Boston Med. and Surg. Jour., 1907, clvii, 655.
  - 5. Barton and Plummer: Am. Jour. Orthop. Surg., 1912-1913, p. 499.
  - 6. Lovett: Am. Jour. Orthop. Surg., 1905, xii, 405.
  - 7. Rich, E. A.: Limitations of Lange's Silk Ligaments in Paralytic Surgery and Substitutes Therefor, THE JOURNAL A. M. A., Nov. 1, 1913, p. 1597.
  - 8. Feiss: Rev. neurol. and psychiat., xi, 307.
  - 9. Vulpian: Am. Jour. Orthop. Surg., 1912-1913, x, 272.
  - 10. Soule: Tr. Am. Orthop. Assn., Philadelphia, 1914.
  - 11. Lund: London, 1872.
  - 12. Willens: Brit. Med. Jour., 1908, ii, 984.
  - 13. Peraire: Paris chir., 1912, iv, 294.

operation briefly consists of the enucleation of the astragalus, fibroarthrodesis of the joint, transplantation of the tendons, and the backward dislocation of the foot. The cases in which it is serviceable have since been much extended by Whitman. Favorable results from the operation have been reported by Dane and Townsend<sup>14</sup> in a series of cases from the Childrens' Hospital, Boston, and also by Lord<sup>15</sup> and others.

The operation has been modified by Robert Jones,<sup>16</sup> who divides it into a two part procedure. His method is not much used in this country. Tubby<sup>17</sup> modifies the operation by using Lange's silk ligaments to strengthen the Achilles tendon after division.

Tendon fixation separately or as an adjunct to astragalectomy has been used by the author in several of his later cases with good results.

#### ABSTRACT OF DISCUSSION

DR. FREDERICK C. KIDNER, Detroit: I can agree with Dr. MacAusland in the use of the Whitman operation, in selected cases, but I cannot feel that so mutilating an operation is necessary in a large portion of paralyzed cases. He has spoken of the rapid growth of the foot following the operation because of the restoration of function. We know that growth can be stimulated to a great degree by ordinary massage, heat applications and other therapeutic measures. Therefore, this argument for the operation is not very strong. As to the function, there is no doubt that the strong, firm foot resulting from astragalectomy is a very useful one, but so are many feet which wear light braces or are in moderate valgus or varus. To my mind, astragalectomy should be limited to severe cases of paralysis in well grown feet.

DR. J. D. GRIFFITH, Kansas City: It seems to me that we have discarded transplantation of tendons, and that if we are discarding the silk ligaments, we have to come to the Whitman operation. Dr. Whitman has shown before and Dr. MacAusland is now showing, that this surgical interference is not interfering with growth in length, size or the function of the foot to any great extent. In these cases of equinovalgus and equinovarus, particularly valgus with calcaneus, there is nothing left to do but this operation.

14. Dane and Townsend: Am. Jour. Orthop. Surg., 1904, xi, 38.

15. Lord, J. L.: The Whitman Operation for Talipes Calcaneus Paralyticus, THE JOURNAL A. M. A., Oct. 11, 1913, p. 1374.

16. Jones, Robert: Lancet, London, 1914, i, 1786.

17. Tubby: Clin. Jour., 1912-1913, xl, 163.

DR. ALBERT H. FREIBERG, Cincinnati: A few years ago, Dr. Whitman felt that the profession was somewhat tardy in recognizing the value of his operation; and I think that events have fully justified him in his attitude. I feel, however, that if he were here today, he would have just as much objection to the trend of events, now that the pendulum has swung too far the other way. There is no question in my mind that his operation has great advantage in suitable cases. I have used it, and shall use it, I hope, very often. On the other hand, it seems to me that there is something wrong with the tendon transplantations of the man who says that tendon transplantations must be given up, to have their place taken by a mutilating operation such as this is, even under most favorable conditions. We have learned that we had expected too much of tendon transplantation. We have also learned that the complicated procedures had to be abandoned, and that it was not possible to convert a flexor into an extensor, or an extensor into a flexor, *ad libitum*; because the muscles would fail to respond to unreasonable demands made on them. There are certain psychologic problems to which the brain will not respond. It seems to me, however, that many of us—evidently not all of us—must have cases of tendon transplantation, done under more or less ideal conditions, which have stood the test long enough to make it impossible to deny the considerable advantages that the patients have received from the operation. It is further understood by men of experience that we cannot switch muscles around as we please and sew them down in an insecure way and have the tendons move freely in the proper direction. We have learned that in cases in which there is fairly isolated paralysis of the tendons about the foot, we may be able to pass tendon under the annular ligament, the tibialis anticus, for instance; and in that way get an excellent result which will stand the test of time, and produce a foot of a degree of functional perfection that is not at all to be compared with the most delightful result after the Whitman operation, useful as that procedure may be in extensive paralysis.

DR. C. M. JACOBS, Chicago: I want to ask Dr. MacAusland what is his average shortening of the limb in his series of cases following this operation. I would also like to ask him whether he has done any other operation—say the Galli—for a calcaneus condition. I was always in favor of the Whitman operation until I tried Galli's method of inserting the tendo Achilles into a groove on the posterior portion of the tibia. My first case, which was done a year ago, gave such excellent result that it led me to discard the Whitman operation for paralytic calcaneus.

DR. EDWIN W. RYERSON, Chicago: The Whitman operation is a very valuable one, but it is not applicable to every type of paralyzed foot. Dr. MacAusland goes just a bit too far in this. The Whitman operation should not be performed

in cases in which there remains strength in the calf muscles. The tibia should not be displaced forward on the foot, because a very undesirable degree of equinus is likely to result. I have seen this in some cases. In cases in which these muscles are strong, one should do astragalectomy, if it is indicated, and should not displace the foot backward on the tibia. I consider that tendon transplantation is by no means obsolete, no matter what you may have gathered from the statements made this afternoon. It remains today an extremely valuable, and the only proper, operation for certain forms of paralysis. The fact that a foot has simply weakness or infantile paralysis is no more reason for doing a Whitman operation than for extracting the patient's teeth. The cases must be considered carefully and individually. The Whitman operation is not applicable to certain cases, and should not be done in them. The cases in which it is especially desirable are cases in which there is great lateral mobility of the foot, where the foot rests on a very freely movable astragalus and is not stable. In cases of dangle-foot, the Whitman operation, as performed by Dr. MacAusland, is very valuable, and is the best procedure devised; but in cases in which tendon transplantation can be done—and there are many such cases—do not remove an astragalus unless it is necessary. I have dozens and dozens of cases in which the results of tendon transplantation are satisfactory to both the patients and myself; and I have other cases in which they are not satisfactory, because we hoped for too much from the operation in the past. We cannot cure a foot that is very badly paralyzed by tendon transplantation, but it has a wide field of application in cases of moderate or isolated paralysis. Such cases can be treated beautifully in this way, and we should not discard the operation of tendon transplantation, which is a therapeutic resource of the greatest possible value in properly selected cases.

DR. WILLIS C. CAMPBELL, Memphis: I have operated in this way in thirty cases with excellent results, but my cases have been selected cases. The type of case in which I found the procedure most satisfactory was calcaneovalgus in which there was considerable power remaining in the peroneal muscles. Out of these thirty cases, or over, I have had two that have had some inversion afterward. The inversion has not been severe and has been correctible by tilting the shoe. I now always tilt the shoe in such cases. I have also employed the method of tendon fixation to the external malleolus and fibula to prevent inversion. It is very important to maintain the right position in putting the foot in plaster. It should be placed in an overcorrected valgus position as well as in moderate equinus with backward dislocations.

DR. J. T. RUGH, Philadelphia: Some of those present saw an operation in Philadelphia about two years ago that combined exactly the same principles as the Whitman operation. It has not received the attention it deserves. It is the Davis

operation and he has chosen to call it "the transverse horizontal section." I have always felt that the Whitman operation was essentially indicated in cases of the calcaneus type of paralysis; and the Davis operation combines the same principles as the Whitman but does not remove the astragalus. The disadvantages of the Whitman operation is the increase of shortening, which must be compensated for by tilting of the foot, with slight resulting equinus. In the Davis operation a transverse osteotomy is done below the astragalus, that is, between the astragalus and the calcaneus. The posterior calcaneo-astragaloïd articulation is separated, and the foot is displaced backward and put in the position of slight equinus. A tendon transplantation can also be done; or where there is no power in the peroneus and where there is a total loss of the tendo Achilles, I have been doing the Putti operation, cutting off the tendon from the muscle and transplanting the tendon into the tibia a little differently from the way in which it is done in the so-called Galli operation, with excellent results—making an absolute ligament of the tendon.

DR. R. L. HULL, Oklahoma City: I have done the Whitman operation in fifty to seventy-five cases. This operation was originally devised for cases of calcaneus and calcaneovalgus, and it is better for them than any other operation. I have done it in a patient three years old, and I have done it in adults of twenty-one and twenty-four years. In every case in which the patient is from three to six years old, I approach the operation with a great deal of enthusiasm; because I know that I can give the patient the best possible functional result—better than from any other operation or series of operations. Recently I have been a little more radical, and have been doing it in a few cases of varus and equinus. It is impossible to know yet what the end results will be; but at present it has seemed to meet the indications better than any other operation with which I am familiar.

DR. C. B. FRANCISCO, Kansas City: In 1907 I assisted Dr. Whitman in adding fifteen or sixteen cases to his original report. Naturally, I have been very much interested in his operation ever since. I think that if we had an operation that met the requirements in every case of deformity of the foot as well as the Whitman meets those of the calcaneovalgus deformity, we should be glad to adopt it. I know what the result will be when I do this operation. You can tell absolutely what you will get—what motion. You will get from one third to two thirds of the normal range of motion in children under ten years. You also know pretty definitely what the foot will look like. In the badly paralyzed cases, you know that there will be a little cavus; and it will take a while for the foot to flatten out but you have no hesitancy about recommending it. When you get into the varus type, that, to me is the hardest deformity that I know of to cure and have stay cured. One of the most distressing things is to manipulate and resect and

do everything you know how to, and get good position and then turn the patient out and lose track of the case, only to have the child return, a year or so later, with the deformity as bad as ever, so that you feel that you have done harm, instead of good. I have not, so far, used the Whitman operation in the varus type, being now trying out the Galli method of fixation of the peronei. I believe that there are certain cases of varus that the Whitman operation will prove satisfactory, as indicated by Dr. Ryerson; the lateral movement type. The operation does away with that. I think that Dr. MacAusland is to be congratulated on having brought the subject before us.

DR. W. RUSSELL MACAUSLAND, Boston: The proof of the pudding is in the eating. I have not heard anyone advocating the value of tendon transplantation without saying, "In almost every case," or a similar qualifying remark. I can say what my results have been in astragalectomy. In one hundred and thirty-five cases, there have been only three cases of varus. This is a very difficult deformity to overcome when it does occur; and it should be guarded against carefully. These cases of varus all occurred in patients living out of town, some of the postoperative treatment being left to assistants. The important thing is to put the foot up in valgus and slight equinus. I keep the valgus during the entire treatment; correct the equinus when the quadriceps is gone, and retain plantar flexion of five to eight degrees when the quadriceps is present. Dr. Freiberg's remarks carry considerable weight. His results from tendon transplantations and those of many others which have come under my observation in Boston are not satisfactory. I have also looked up the results of arthrodesis in young children, and found that in 90 per cent. of the cases the old deformities recur or new ones appear. If tendon transplantation does not add to the stability of the foot and increase its function, it is not the best operation. When we take a tendon from one place and put it in another, we weaken the tendon and also weaken the side that it came from, and put it where it never can act to its full strength. I did not say that I used the Whitman operation in every case. If by tendon transplantation any of the surgeons here can obtain correction of the deformity, universally, increase function and secure stability, then it is certainly an operation for them on a par with astragalectomy. Dr. Jacobs asked about the average shortening that I obtain. Astragalectomy does not shorten the leg. The shortening in my cases was about  $\frac{1}{2}$  inch to  $1\frac{1}{2}$  inches. In cases with the os calcis vertical the malleoli naturally lie nearer the ground following astragalectomy. The Galli operation has undoubtedly a prominent place in the treatment of infantile paralysis. Up to the present, however, my experience has not been such that I care to make any statements about it. I shall not do so until I have formed definite conclusions. Dr. Ryerson says that the pendulum has

started to swing too strongly in the direction of astragalectomy. Dr. Whitman has tried to impress the value of astragalectomy as compared with tendon transplantation before, and failed. With regard to this operation, it is in a similar plane with all the other surgical procedures that he has advanced. Nothing has been found as a substitute for them. Dr. Campbell spoke of inversion. I had that happen in three cases. These inversions are very objectionable deformities. I was able to correct them by placing the fibula further forward, holding it there by means of the Galli operation; suturing the peroneal tendons into the fibula. These cases are all right now.

## THE PROGNOSIS IN INFANTILE PARALYSIS

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Despite the great advances in recent years in our knowledge concerning the etiology and pathology of acute myelo-encephalitis, and notwithstanding the numerous excellent papers recently published on the early treatment of this disease and its effect on the outcome of the paralysis, few diseases of such serious nature are so little understood by the medical profession at large as this one. We have been powerless to prevent the spread of epidemics; unable to make the correct diagnosis until after the advent of a frank paralysis. Treatment both prophylactic and curative has been futile, and the correct outlook as to the future progress of a given case is rarely foretold. Is there any wonder, therefore, that so many patients fall into the hands of quacks and irregular practitioners?

This at least has been the writer's experience in the recent epidemic of infantile paralysis in Ohio. He has seen many patients, improperly managed as to treatment and functional use, grow worse and lose what little muscle strength was left in the afflicted muscle groups, because of the false prognosis as to the duration and the course of the treatment and the final outcome as to function. One has only to consult the recent publications of Lovett and Buchholz to realize the possibilities for partial recovery of function and the tremendous importance of properly graduated

muscle treatment and the baneful effects of over-stimulation, excessive use and overexertion.

It is of vital importance that the physician in charge in the acute stage of this disease should be conversant with the true course of the recovery of muscle function. In the inability to diagnose and specifically treat the beginning stages of infantile paralysis, very little additional harm is done in the present state of our knowledge; but with a promise of a perfect cure the seed is sown for a lack of appreciation for a good functional recovery, for the lack of necessary endurance and patience on the part of the parents, which results in desperate attempts to force the victim into the evils of overexertion and overstimulation, with its consequent deplorable effects of loss of muscle tone, overstressing and weakening of the afflicted parts. No one feature of the misunderstanding prevalent in the medical profession today concerning this disease is so conducive of harm as is this ignorance concerning the true prognosis.

Epidemic infantile paralysis is an acute, contagious, infectious disease attended with a high mortality, the rate varying from 9 to 20 per cent. in various epidemics, and in the vast majority of cases the disease occasions permanent muscle damage of greater or lesser extent and renders the victim a "cripple." The grave character of infantile paralysis can be more readily grasped if this disease is contrasted with others concerning whose epidemic seriousness there is no doubt. In typhoid fever the morbidity and mortality are about the same, and the length of the stay in bed is not unlike; but in typhoid the convalescent patient gains rapidly in strength and well being and is soon restored to normal function. In infantile paralysis, convalescence is only the preparation for a long and tedious struggle against crippledom.

The death rate is directly comparable to the severity of the infection. The seat of the lesion also plays a

most important part. The upper cervical and cerebellar types, with their paralyses of the muscles of respiration and deglutition, are responsible for the majority of deaths.

Complete recovery from the paralysis is not as frequent as some writers would note. Mark Richardson and Sever state that 25 per cent. of all their patients made a complete recovery. They also note that in half of the recovered cases the onset was mild and the return of complete function occurred rapidly, i. e., in from four to six weeks; but they further state "no one can tell at first which case is going to make such a recovery."

On the other hand, many recent writers, among them O'Reily, Howard and Schouffler, note that "complete recovery occurs but rarely and that there is rarely a case so mild that it can be absolutely cured and allowed to pass out of observation." My own experience in the Ohio epidemic of 1915 gave me only two cases, out of the seventy-eight which I saw personally or which I know of from personal communication with the attending physician, which can be said to have undergone a complete cure. One was a case of left facial paralysis in a child of 3, and the other a marked weakness of the thigh muscles in a child of 6, the attack being so light as to have been entirely overlooked by the attending physician.

When complete recovery takes place spontaneously, it is said that the climax is reached not later than six weeks from the time of onset.

Partial recovery of muscle power with a more or less satisfactory recovery of function is the universal rule. No case is so bad that there is not some opportunity for improvement, and almost all patients with paralysis of the lower extremities can be put on their feet and taught to walk. It has long been taught that, as a rule, the intensity of the paralysis is in proportion to the severity of the attack and that the mildest cases

recover easiest; but this rule is not universally true and the physician must be on his guard not to be misled by the seeming insignificance of the primary paralysis, lest the afflicted muscles be allowed to over-stretch and become weakened from misuse. I have in mind a case of peroneal palsy so mild that the attending physician, a pediatrician of note, suspected a coxitis on account of the limp. The consulting orthopedist ruled out coxitis, and as the child was evidently suffering from rickets, put the child on antirachitic treatment. Four months later (now in midwinter) when I saw the child again, it showed a tendency toward varus and an evident weakness of the peroneal muscles.

The prognosis for recovery in a given case depends on many factors, most of which represent unknowns, and only one being under the direct control of the physician. These are:

1. The amount of actual permanent destruction of the ganglion cells of the anterior horns, or of the brain.
2. The amount of nerve cell congestion and edema, and neuritis.
3. The regenerative and reconstructive powers of the nervous system.
4. The amount of muscle degeneration and over-stretching (loss of tone).
5. The presence of bone and joint deformities.
6. The curative effect of proper treatment.

The amount of actual permanent destruction of the ganglion cells of the anterior horn depends on the severity of the attack, but there is no way of differentiating it, in the early stages, from the neighboring cell congestion and infiltration, and concomitant neuritis. Complete paralysis, loss of the reflexes and the presence of the reaction of degeneration only indicate the amount of damage, not its permanence. Quvastec and Krafft-Ebbing were always of the opinion that the severe pain complained of in so many cases was due to

a neuritis (root symptoms), and that the greater the pain the more the symptoms aforementioned might be held to be due to this neuritis. It is no longer the fashion, however, to speak of neuritis in describing the pathology of this disease. Flexner has recently called attention to the universal involvement of neighboring nerve cells in the congestion and edema accompanying the ganglion cell destruction. Any paralysis due to this congestion, to edema or to neuritis is sure to be recovered from.

The early spontaneous improvement in function, the recovery of the reflexes and loss of the reaction of degeneration, are a good indication of the regeneration and reconstruction of the nervous system. A voluntary motion is a complicated process and is set into action by the activity of a large number of anterior horn cells situated in different horizontal planes; and even if a large part of these centers have been destroyed by the inflammatory process, given the proper stimulation, the nerve impulses will sooner or later seek to find a way by which they may pass around this break in the "connecting circuit," so to speak, and again innervate the damaged muscles. There is, however, no time limit beyond which this spontaneous improvement cannot take place. Six months has been arbitrarily placed as the limit for spontaneous recovery. It is told that the greater part of such recovery does take place within this time limit; but Hoppe of Cincinnati has reported a case in which improvement occurred after twelve years. If six months were really the limit for spontaneous recovery, it is equally true that a great deal of further improvement can be secured, provided the patient is placed under proper treatment.

Too much time and effort need not be wasted in securing the electrical reactions. The ordinary practitioner and ordinary hospital are absolutely unequipped to make accurate electric observations. At their best, they only indicate the nature of the change (neural) and are not an evidence of the curability or

incurability of the process. An early recovery from the reaction of degeneration means, of course, an early improvement in the underlying cause of the muscle paralysis or weakness; but its continuance and the persistence of the loss of the reflexes does not mean that recovery of function cannot take place. The method of Lovett and Brown, in determining the amount of real paralysis or weakness in measures of pounds of pull, is a real advance in our methods of determining the amount of the muscle damage. But here, too, we are confronted with the problem that we are dealing in great measure with young children who are prone to struggle and cry, and in whom repeated measurements must be made before trustworthy ones can be secured, and, as in the case of the electrical reactions, it is not a method to be advised for the general practitioner or the ordinary type of general hospital.

Of serious import in the prognosis is the loss of muscle tone, overstressing of muscle and tendons, and the presence of bone or joint deformity. Robert Jones has clearly shown that overstressing can be as serious as actual persisting paralysis, and that, in many cases, ganglion cell recovery has been completely masked by the loss of muscle tone. It is therefore of vital importance that the limb be placed at once in a position of muscle balance or, where necessary, muscle unbalance in overcorrection, to favor a contracture of the paralyzed or weakened muscle groups. One of the most amazing improvements is that seen in a case of drop wrist, kept up by an overstressing of the extensors, after it is put in a Jones splint, or, at times of a flail shoulder when the arm is hyperabducted in the manner advised by Silver of Pittsburgh. Deformities, especially equinus, with contracture of the Achilles tendon, must be avoided; and it is not out of place to remind the practitioner that the removal of the bed-clothes from off the toes—something which must always be practiced—will not alone accomplish this.

Volkmann trough splints, with horizontal bars to prevent rotation, must be used and the feet accurately bandaged therein.

Of vital importance in the prognosis is the carrying out of the proper treatment to strengthen the weakened muscles. The first factor in this treatment is rest, complete rest to the muscles in the physiologic position of the joint (Lorenz). There has been a quiet controversy concerning the length of this absolute rest in bed. Judson at one extreme advised eighteen months, Townsend one year, while Lovett in a recent publication advocated that the children be put on their feet as soon as possible. Against the latter stand I must protest most earnestly. There is a great deal to lose and nothing to be gained by a too early resumption of walking. It is the antithesis of rest. The day walking is to be resumed by the convalescent is the beginning of a new era. It is the resumption of the pleasures and activities of life; and with its dawn the restraints of medical discipline, the precepts of the physician and the ideals of treatment are alike thrown away. The boy longs for his bat and ball, and the girl for her jumping rope and dancing, and as soon as possible the normal activities of daily life are attempted. It behooves us, therefore, before allowing such freedom, to weigh carefully the dangers of overexertion against the good of early resumption of walking. The graded massage and muscle training of the ideal method of treatment can stimulate the weakened muscles only a few minutes or possibly a few hours a day. But active exercise and walking stimulate the unparalyzed and stronger muscles for ten times as long. What wonder is it, then, if the patient soon returns with a deformity brought on by the contracture of the antagonists?

With rest in bed combined with the use of massage and the interrupted galvanic electricity to keep up the tone and the vitality of the muscle body, resistance

exercises and muscle training seeking to open new avenues of nerve communication for the reestablishment of nerve control and recovery of neuromuscular strength, we accomplish most. With these methods we find the chances for the recovery of function multiplied manyfold, and cases seemingly hopeless are often restored to activity. The use of braces or other mechanical appliances and orthopedic operations should never be undertaken before a muscle survey is made in the manner advised by Lovett, for the purpose of determining what particular group of muscles and what particular muscle function must be assisted or guarded.

Whenever possible, parents must be warned lest a badly paralyzed and inactive child overeat and become helpless on account of excessive weight. At the Gates Hospital for Crippled Children, we have had in our short career of one year, two cases in which excessive adipositas was the deciding factor between the wheel chair and walking.

#### SUMMARY

The death rate of epidemic infantile paralysis is as high as that of any of the most serious diseases of childhood.

While a few perfect complete cures are authentically reported, the vast majority of patients make only a partial recovery of muscle power with a more or less imperfect functional result.

Spontaneous cure unassisted by treatment is at its maximum in from three to six months.

Careful treatment—physiologic rest, graded massage, stimulating electric applications, resistance exercises, muscle training, etc.—improves greatly the chances for partial recovery and lengthens indefinitely the period in which such recovery can take place.

Misuse, overwork, overstimulation, overexertion, contractures and deformities are particularly harmful and detract from the power of recovery and often destroy what little muscle power has been gained.

The prognosis should always be guarded, conservative and truthful, lest the parents, expecting too much, should in their disappointment throw away all rightful gain in strength, power and function, while seeking the chimera of a "perfect cure." With proper treatment, followed by braces, orthopedic operations and the like, almost every patient with infantile paralysis should, so to speak, "be put on his feet" and acquire independent and useful function of the afflicted member.

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#### ABSTRACT OF DISCUSSION

DR. HENRY W. FRAUENTHAL, New York: It is my personal experience that what these cases lack is intelligent observation. We are trying to lay down rules for general practitioners, and should teach that if a child is under intelligent observation, it will not have deformity and contracted muscles. Regarding the matter of keeping the patient on the back for six months or a year to a year and a half, I think that if the heart is so damaged, it will do more harm, almost, than the paralysis, taking months to recover from the effect, based on the experiences of the Mayo Clinic. I start to treat my patients right after the temperature drops to normal, and sometimes before, and have seen no damage ensue. The damage, I think, all comes from neglect, from putting on a brace and saying, "Goodbye; come back again in three months." Braces are not the treatment; plaster of Paris is not the treatment; the thing to do is to try to establish the function of the muscles. If you keep the patients under observation, you do not have these terrible results, as have been described here today. It is sending them home and having some one else attend them that causes the trouble. If they have intelligent massage and electricity, under the guidance and supervision of a doctor, and later, muscle education, preferably by reflecting the image in a mirror, you get higher muscle perfection than in any other way. We are responsible for the ill results of our neglect. The treatment of these cases should not be turned over to the family physician or the parents, unless they have constant supervision by us. No brace device will keep a foot from becoming deformed, unless the brace does more damage than the disease itself.

DR. WALTER G. STERN, Cleveland: It is all very well for us to tell each other that we have our patients under continuous observation, perfect control and all of that, but do we in reality enjoy such an ideal state of affairs? This point cannot be determined by what we think our patients

are doing, but only by a survey of the state of the cripple. We in Cleveland are now making such a survey. These patients go from one doctor and from one hospital or dispensary to another. Your records show that they are coming regularly to your dispensary in the afternoon, but on investigation you will find that they have been to some other dispensary in the morning and perhaps will consult the osteopath or chiropractor at night. There are very few patients with infantile paralysis who have not consulted and have not been treated by a half-dozen different physicians or agencies. If this be true, then having them under "perfect control" is impossible. The day the child wants to get up is the day that the mother gives a party and from that day on the limb is used as much as possible. We have heard much that massage should be graded and careful. This is what good treatment ought to give every case. But how careful and how graded are the attempts of the child to dance or jump the rope? By these violent exercises the patient can undo in a half hour of activity all the good effects of weeks of careful muscle training. This is why those with more experience than I, have advised that when the acute stage is over the child should be kept at rest for a comparatively long time, and while in bed given the exercises, massage and muscle training as indicated by the condition present.

## LOCALIZED OSTEOSPONDYLITIS

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WILLIS C. CAMPBELL, M.D.  
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During the past three years I have seen four cases with varying symptoms, showing certain local changes in the vertebra, which appear to be analogous to mono-articular osteoarthritis, for which reason I have used the term "osteospondylitis." The condition is probably known to others as a limited spondylitis deformans of the hypertrophic type, but I can find no accurate description in literature.

The process is decidedly local and seems to be an affection of one intervertebral disk. The roentgenogram shows crescent shaped lamellae of bone, which are thrown from the body of one vertebra to its adjacent fellow, and may completely encapsulate the disk, producing solid external fixation of two vertebrae, or only a part of the circumference may be involved. In some the bony bridge may be incomplete and connected by only one extremity to the vertebral body, and at times there may be no apparent union of either extremity to the bodies, which is probably explained by assuming that the process was fibrous in the early stage with later ossification. The bony lamellae may connect the bodies at their margins, the so-called "lipping," or may extend from the center of the exterior surfaces. The bodies or other portions of the vertebra show no abnormalities in shape, size or structure. In one acute case there was atrophy of the disk with bony substitution.

I have repeatedly seen similar anomalies in other spinal affections, especially spondylitis deformans, but always multiple and often involving the entire spine,

and associated with definite bony changes in other portions of the vertebra itself (bodies, articular processes, ligaments, etc.). Garrod reports spondylitis deformans in one articulation, but before the days of universal use of the Roentgen ray. Goldthwait states that only a small area may be affected, but more frequently one region and often the entire spine.

In all four of my cases the affection was in the lumbar region.

Fig. 1.—Spondylitis deformans, showing spurs and crescents about the intervertebral disks with marked flattening and atrophic changes in all parts of the spinal column.

#### REPORT OF CASES

CASE 1.—L., man, aged 40, was first seen at the Baptist Memorial Hospital, Feb. 22, 1913. In December, 1912, he had lobar pneumonia from which he recovered, to be followed in a few weeks with pain in both lower extremities and gradual flexion of hips until walking was impossible. On examination the spine was rigid from extreme muscular spasm, both hips flexed 90 degrees, evidently double psoas

contraction. Diurnal temperature, 99 to 101. Blood and urine negative. Roentgenoscopy revealed bodies of fourth and fifth lumbar vertebrae united by bridge of bone extending from the center of the exterior surface of the body of the fourth to the same point on the fifth, surrounding the intervertebral disk, which was atrophic and partially ossified. Clinically this case was identical with tuberculosis of the lumbar region, the diagnosis of "local osteospondylitis" being made by the Roentgen ray. The causative agent we presume was probably

Fig. 2.—Spondylitis deformans, side view.

pneumococci, and a sequela to lobar pneumonia. Bradford frame with extension and hyperextension followed by plaster jackets gave perfect relief with no recurrence to present time. Repeated roentgenograms show no extension of process.

CASE 2.—R. L., man, aged 22, had gonorrhea, December, 1910. In May, 1911, he had severe pain in right lower quadrant of abdomen, also pain in back which radiated down right thigh and knee. Does not know whether fever existed. The appendix was removed with slight if any relief, and after two years, May, 1913, was operated on for "adhesions" with recurrence of symptoms, when a kidney exploration was con-

sidered. Patient very nervous and at times hysterical. Examination revealed tender area in the region of appendix. The movements of the spine were limited in side bending to the left, free to the right and slightly limited in flexion. Temperature, blood and urine were normal. Roentgenoscopy revealed bridge of bone on the right lateral aspect of lumbar spine between third and fourth vertebrae. Diagnosis, localized osteospondylitis. Extension of head and both lower extremities on Bradford frame followed by fixation to spine gave decided relief with no recurrence to the present time.

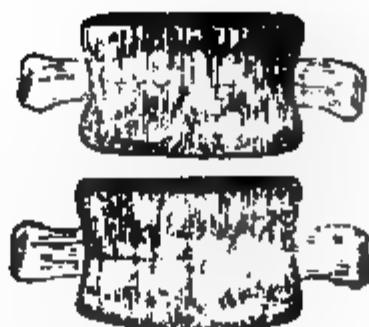
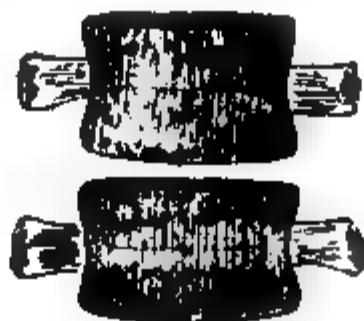


Fig. 3 (Case 1)—Extension of superior border about intervertebral disk shows partial ossification, being surrounded by bone extending from the center of the exterior surface of adjacent vertebrae.

CASE 3.—A., man, aged 27, single, fell from horse at age of 12, and wrenched back at 22, but no serious inconvenience followed either injury. For past three years has suffered pain in lumbar spine and in both lower extremities. Examination, June 1, 1915, revealed very slight limitation of motion in all directions. Roentgenogram shows bony bridge between second and third lumbar vertebrae, right lateral aspect. Evidently "localized osteospondylitis." Extension, hyperextension with later fixation gave relief.

**Fig. 4.**—A crescent may be seen, as in Case 2, which indicates fibrous bands joining adjacent vertebrae with incomplete ossification.

**Fig. 5.**—Roentgenogram of Case 3 indicates bony lapping of adjacent borders about intervertebral disk; no change in disk or other portions of spine.

CASE 4.—Mrs. D., aged 40, in July, 1914, had suffered for one year with very acute attacks of pain in kidney region with referred pain to vulva and thigh. No abnormality could be found in urine following attacks. Roentgenoscopy was advised by general surgeon, who suspected renal calculi, after which, patient was seen in consultation, July 11, 1914. The roentgenogram showed crescent of bone between second and third lumbar vertebrae surrounding disk. No other region of the spine was affected. Diagnosis, localized osteospondylitis. No treatment was instituted, and I have not heard from patient since.

Fig. 6 (Case 4).—Extension of superior border about intervertebral disk, the adjacent vertebrae above showing no change.

#### COMMENT

Evidently Case 1 was an acute pneumococcic infection of the cartilaginous disk between the fourth and fifth lumbar vertebrae, and could not clinically be differentiated from tuberculosis of this region. Pneumococcic infection of large joints is a rather common sequela of pneumonia, but no mention could be found when the spine was affected. The other three were of insidious onset and do not show so complete an osseous bridge, and are probably analogous to mon-

articular osteoarthritis occurring in other joints. In operating on the hip for this condition one will frequently find a complete bony hood extending from the margins of the acetabulum to the neck of the femur materially restricting motion, though the joint proper may remain intact.

Two useless major operations were done in Case 2 and a third proposed, on account of the referred pains. After three years of definite symptoms, permanent and lasting relief was attained by simple and persistent orthopedic measures. In Case 4, kidney stone was suspected and operation seriously considered until adverse opinion was given after seeing the Roentgen-ray plate.

As spinal movements are not usually materially impaired (except in acute types), a diagnosis of abdominal lesions are frequently made from the referred pains, and the patient submitted to useless major operations; but this is also true in other spinal affections, especially tuberculosis of the vertebra with psoas abscess and contraction on the right side simulating appendicitis, which should give the spine more serious consideration in differential diagnosis of affections in the abdomen.

The etiology is probably the same as in monarticular osteoarthritis. In no case was there a definite history of trauma in close relation to the affection; besides, I was unable to find similar changes in the roentgenograms of undoubted traumatic spines.

Three cases were relieved by simple orthopedic procedures, as no focal infections could be found.

Differential diagnosis of spinal lesions by the Roentgen ray is very meagerly considered in literature; in fact, few textbooks mention local manifestations except traumatic and tuberculous, for which reason the subject was considered worthy of presentation at this time.

Exchange Building.

## ABSTRACT OF DISCUSSION

DR. F. J. GAENSLER, Milwaukee: It is well for all of us to be reminded constantly of these referred pains. As was shown in one of the histories, the patient had been subjected to a number of operative procedures, and others were contemplated. In considering the cases cited the idea naturally suggests itself, as it did to the essayist, that the condition in question is an early localized lesion of the generalized process, which we recognize under the name of hypertrophic arthritis of the spine. It is perfectly conceivable that calcium deposits may occur much earlier in certain areas than in others, and in such instances the condition would appear to be a local one rather than generalized at least for the time being. Whether the new term osteo-spondylitis, or any new name, should be given to this condition, because it is merely a localized process, is a debatable point. Dr. Murray, of Liverpool, some years ago called my attention to the fact, that these hypertrophic deposits of the spine are rarely found on the left side of the bodies of the vertebra, while they may be very prominent on the right. He suggested at that time, that the pulsating aorta, probably prevented the deposit on the left. Since that time, I have always examined museum specimens with that point in view and have confirmed his observation. The diagnosis between a localized process of this kind and tuberculosis may be difficult at times. I recall one of my own cases, in which there was a very definite spike in one of the upper lumbar vertebrae with a loss of substance in the vertebra immediately below. Because of the unequal limitation of motion and the marked bony deposit early in the disease, I decided in favor of a local condition, such as that described. Future development proved the diagnosis to be correct.

DR. ALBERT H. FREIBERG, Cincinnati: The cases which have been shown by Dr. Campbell are very interesting, but I think that they are far from being rare. We see cases of that kind, every now and then; but Dr. Campbell, I think, has shown us cases of infectious osteo-arthritis of the spine. I object very seriously to a multiplication of names. "Localized osteo-spondylitis" is unscientific, as the disease is not always localized in these cases, and because such a term produces confusion. We do not need a new term for this disease. I have seen this condition half a dozen times or more, and on both sides at once; and I think that it is a part of the condition which we call infectious osteoperiostitis or osteo-arthritis, as the case may be. In one of my cases, there was some difficulty in diagnosis; because, soon after the onset of the disease, abscess formation was apparent. I do not remember what the etiology of the case was, but we were fairly clear about it. Unless we are dealing with a mixed infection which is unusual in these conditions, they very soon clear up in the roentgenogram by the appearance of new bone, which we do not see as an early manifestation in tuberculosis. When we see new

bone early in the course of disease, we should be cautious about making a diagnosis of tuberculosis; for it is not a part of the pathologic anatomy of that disease except late as a part of the process of repair.

DR. ROLAND MEISENBACH, Buffalo: In the main, I agree with Dr. Freiberg. I do not believe that Dr. Campbell wishes us to understand that the spurs which he has shown represent a local process, but rather a localized entity of a general metabolic diathesis. I believe that in some cases the osseous spurs are seen in a very early stage, even an earlier stage than Dr. Campbell has shown. I especially refer to patients complaining of backache, with only slight muscular spasms, or very slight restriction of spinal motions, due rather to muscular spasms than to the actual bony formation. I believe that these muscle spasms are produced by very small spicules such as Dr. Campbell has shown, but in an earlier stage. These I have seen in a number of cases to be embedded in the intervertebral disks, and later on they grow in size and also appear in other joints than the vertebrae. I think, however, that it is very important to make early diagnoses of these cases, if possible. I have followed some of these cases and have had an opportunity to make a careful study, including the metabolic study, by which it was possible to diet the patient according to the metabolic chart rather than at random. It is also interesting to note how these charts would change. One of the earliest objective symptoms which is noted is a slight rigidity in the spine. The early diagnosis can sometimes be made by noting clouded intervertebral disks on the roentgenogram and in rare instances, actual small spicules can be seen. These are often the patients who complain of vague rheumatic conditions. My plea is for early diagnosis.

DR. W. RUSSELL MACAUSLAND, Boston: This nomenclature is very confusing. It seems to me that the roentgenogram Dr. Campbell showed and the clinical picture correspond to a monarticular infectious process. We see these spicules or spurs thrown out in different stages in other monarticular infections—notably in the elbow joint, around the acetabulum, and on the bottom of the os calcis. It seems to me that this condition can be classified under a much simpler terminology; that is, infectious arthritis of the spine with spur formation in the lateral ligaments.

DR. J. T. RUGH, Philadelphia: I want to mention two cases of the older type with pain that I have treated. I anticipated Nature's efforts at ankylosis of the spine, and placed bone grafts after the method of Albee, with excellent results.

DR. W. C. CAMPBELL, Memphis: I had no idea of originating a new term. "Osteospondylitis" would be the natural term to apply to the same condition in the spine that in a joint we call osteo-arthritis. I used the term "local" as the process in all of my cases was confined to one intervertebral disk in the same manner that monarticular osteo-arthritis of a joint is

confined to one joint. Such a process, of course, may originate at a distant focus. If "osteospondylitis" is confusing to anyone, I am perfectly willing to apply "osteo-arthritis" or any other term, for it was only my desire to call attention to certain local processes with referred pains which had been diagnosed as acute abdominal lesions. Two of the cases were observed over a long period of years, and show no extension to other portions of the spine. All responded to simple orthopedic measures. I do not believe that the aorta has any influence on the distribution of the process, as suggested by Dr. Gaenslen, for the condition is frequently bilateral or on either side. I stated that I did not regard the condition as uncommon, though one can find scant reference to such local changes in the spine; but there is ample discussion of analogous affections in joints—i. e., monarticular osteo-arthritis.

## SYPHILITIC BONE AND JOINT LESIONS SIMULATING TUBERCULOSIS

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SAN FRANCISCO

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Every paper should present its special points in the beginning so that the attention of those really interested may be fixed. This paper aims to give two special points: first, that there is a considerable number of syphilitic cases simulating tuberculosis and other bone and joint lesions that escape recognition; second, that there is a considerable number of cases of bone and joint syphilis that does not give a Wassermann reaction.

In the past year or two I have seen at least eighteen cases of bone and joint syphilis that have given negative Wassermann reactions. Some of these were unmistakable syphilis, as revealed by Roentgen-ray examination. In others the nature of the process could not be told in this manner. In these two groups of cases the clinical histories are strikingly similar in the individual cases in each group. In those frankly syphilitic on Roentgen-ray examination the histories are all the same, pain in the affected part, frequently more marked at night, and little or nothing else. They have each been in the hands of one or more physicians, some of whom have suspected syphilis, but on account of the negative Wassermann they have been regarded as something else. In this group there were four cases, all of which promptly improved on the administration of mercury and iodids.

In the second group, the larger numerically, the lesions were in and about the joints, rather than in the shafts of the bone as in group one, and in these cases,

too, there was great similarity in the histories. Each of these cases had been treated by one or more doctors, many of these patients had been in institutions, teaching institutions or hospitals, and their trouble had been regarded as tuberculosis and they were treated accordingly by immobilization or operation.

As case histories are exceedingly boring, I will cite but a few and make these as short as possible.

CASE 1.—L. L., Chinese boy, aged 5 years, came to the Stanford University children's clinic with a sore on the back of his hand. He was sent to the surgical clinic, where, after a little time, the diagnosis of tuberculosis of the carpal bones was made and confirmed by the Roentgen ray. He was kept under observation in the surgical department for about a month; then, as the lesion was regarded as tuberculous, the child was transferred to the orthopedic clinic. It was then ascertained that he had had this sore on the back of his hand for about ten months. At this time he had the hand in plaster of Paris, and through a window in the plaster it could be seen that there was some swelling and two sinuses. The sinuses did not seem to be tuberculous, so the boy was put on mercurial ointment and iodids and improved rapidly in spite of the fact that the Wassermann had been negative shortly before the treatment was begun. All plaster was removed, and the boy made a rapid recovery. A guinea-pig injected with some of the material from the sinus remained perfectly well.

CASE 2.—F. M., white man, aged 42 years, sustained a fracture of the lower end of the radius in December, 1913, which healed without any trouble. Oct. 7, 1914, the man returned to the surgical clinic, complaining of pain and swelling of the right wrist. There was diffuse swelling, pain and limitation of motion. Roentgen-ray examination at that time showed probable tuberculosis of the wrist, with a possibility of syphilis. He was transferred to the orthopedic clinic six months later after having been treated by immobilization by means of plaster of Paris. As the diagnosis was not clear, the man was allowed to go without any support, to see what would happen. The condition remained the same, certainly no worse. The man had no knowledge of any syphilitic infection and his Wassermann was negative in July, 1915. He was put on mercurial ointment and potassium iodid. His pain and swelling disappeared and motion in the wrist increased. By the middle of August the man was practically well, though with some limitation of motion in the wrist, probably due to his old fracture.

CASE 3.—This case was extremely instructive. A white child, aged 2 years, was brought to the clinic complaining of swelling in the foot and lameness, which had begun about two months before and was gradually growing worse. At that time in the children's clinic syphilis was suspected, but the mother took the child away and did not return for seven months. During these seven months the child had been operated on by two surgeons, independently, and the mother was told by each one that the condition was tuberculosis. When the child was brought back a Wassermann was made, which was negative (there had been no medication). There was a small sinus at this time at the seat of one of the operations. This child was also treated with mercurial ointment. The sinus closed rapidly and the child improved very quickly. This child gained 2 pounds in weight in three weeks after beginning the mercury. In six weeks all the signs and symptoms had disappeared.

CASE 4.—K. H., white, aged 2½ years, was brought to the clinic with swelling of the ankle that had appeared at 2 months of age. This child had been treated at one of the teaching universities over a period of twenty-two months as a case of tuberculosis. The treatment was immobilization by means of plaster of Paris. During this time two sores appeared about the ankle which kept discharging. Wassermann on the mother, father, and child were all negative. There seemed to be a slight fusiform swelling on the fibula, which showed some periosteal thickening on Roentgen-ray examination. The Roentgen-ray report read in part, "suggests syphilis of fibula, possible tuberculosis." On this finding the child was put on mercury and all plaster removed. The sinuses healed quickly and the child improved rapidly. In about two months the symptoms all disappeared and the child was practically well. Treatment was, of course, continued. A fusiform swelling at the upper end of the ulna, discovered accidentally in the examination of the child, seemed to remove all doubt as to the nature of the process.

CASE 5.—Mrs. G., aged 32 years, was admitted to the hospital complaining of pain and swelling of the right ankle. Without going into all the details, as this was an extremely obscure case extending over a long period of time, suffice it to say that it was at first considered to be an infectious arthritis, then as tuberculosis of the ankle, and finally as syphilis, on account of improvement under mercury as a therapeutic test, even though the Wassermann was negative. Following an intravenous salvarsan and continuing the mercury this patient has remained entirely well.

These five cases were selected at random, and on account of this method of selection the proportion of ankle cases is unduly high. Practically all the large

joints have been represented in this series of cases. Eighteen such cases have been seen, five of the ankle and foot, three of the wrist, three of the hip, one each of the elbow, knee, and back, four of the shafts of long bones, all of which have been under the care of competent physicians, and all of which had been regarded as some condition other than syphilis, most frequently tuberculosis. This would seem to indicate that a large number of such cases are going about, for the experience of no one man or institution is peculiar.

The consideration of these cases brings up several interesting questions: Why do we get so many negative Wassermann reactions in bone syphilis? The percentage I am not able to state, but it seems fairly high, at least 10 per cent. Is it because of the chronicity of the disease, and the lack of amoebocytes in the blood, not sufficient being set free to bind the complement? In a manner, it is, perhaps, somewhat comparable to the fact that in a chronic, pyogenic abscess there is no increased leukocytosis. Another point that these cases emphasizes is that fixation of syphilitic joint neither gives relief nor aids in a restitution of the part to normal.

Another point is the large proportion of children in these cases, eight out of eighteen, or really eight out of fourteen, being under ten years of age, quite a contrast to the ordinary teaching that syphilitic joints are not common in childhood.

Another question that comes up is what we are to consider as the most reliable test of syphilis. To my mind it is unquestionably the therapeutic test, and lastly the question of the therapeutic test as a diagnostic method. It is my impression that this should never, or almost never, be omitted in trying to arrive at a conclusion concerning the nature of a chronic process in and about a joint. Exception may be taken to this, but in the present state of our knowledge it seems to be the best test we have for syphilis, and without it one is never sure of his diagnosis.

## ABSTRACT OF DISCUSSION

DR. H. W. FRAUENTHAL, New York: Ten years ago, I read a paper on syphilitic bone and joint conditions, and I was surprised at the small amount of literature in America on the subject. The orthopedic institutions in the United States had very few cases of bone and joint syphilis in their record. I was also convinced of its rarity in another way; in asking some of the leading specialists in New York City to discuss the frequency of these conditions, most of them said that they had never seen bone or joint syphilis. After collecting a number of cases I concluded that syphilis of the bone and joints was much more common than it appeared to be. The reverse was true on the continent. Most continental observers said it was common in children and adults. Fournier says 42 per cent., and Von Hippel 56 per cent., or more than half. In New York I found it almost impossible to convince others that the Roentgen-ray findings meant syphilis, and that anti-syphilitic treatment cleared up the joint conditions. After the Wassermann test came into vogue, and was used uniformly in all our cases we were surprised at the result. We now find that in almost all blood tests we have 15 per cent. of Wassermann positives. These findings are checked up by other laboratories. Where we failed to get Wassermann positives and the roentgenogram indicated that it was syphilis, by giving salvarsan and neosalvarsan, we later often got a positive Wassermann. Where the child was negative, and the father negative, as the father took treatment, and the child did not show a Wassermann positive the mother never was treated. She often showed a positive Wassermann. I have seen persons treated for six months to two years for tubercular joints in cases regarded as tubercular, that yielded promptly to salvarsan and mercury. Some of these are interesting in their apparent persistence in the appearances of tuberculosis before mercury and salvarsan were tried. One case, that of a married woman, had brace treatment for a time. Then as the appearances of the roentgenogram were such that one would think that she would get motion in the joint, she had treatment at another institution for a year and a half with the Zander apparatus and massage, in order to get motion. They failed to obtain any motion in the knee joint. She gave a 4 plus positive Wassermann. A single dose of salvarsan and inunctions over her joint resulted, inside of ten days, in giving her 45 degrees of motion. Another case, that of a child with keratitis and Hutchinson's teeth, which had been treated a year and a half at another institution for tubercular knee joint, under a single injection of salvarsan and inunction of mercury for two weeks, got a normal range of motion; although there was an inch and a half of difference in the two limbs at the beginning of treatment. After four weeks both were alike. I think that if it were a custom to take a Wassermann blood test in the case of every

child, and then extend it to the mother and father, a number of cases thought to be tuberculous would prove to be syphilitic.

DR. JOHN RIDLON, Chicago: About thirty years ago, I showed a group of cases before the Orthopedic Section of the New York Academy of Medicine, that I believed to be cases of syphilitic joint disease in children; but not one man there would admit that they were syphilitic, and Dr. Shaffer even went so far as to say that the result of antisyphilitic treatment proved nothing, because Dr. Knight, at the Hospital for the Ruptured and Crippled, had always given mercury and iodid of potash for tuberculous joint disease and had obtained wonderful cures in such cases by this means. That was before we had the Roentgen ray, the Wassermann test or tuberculin test to help us in the diagnosis. There is no question of the fact that some children have syphilitic joint disease who do not give a positive Wassermann reaction; and it is also true that a certain number of syphilitics do have tuberculous joint disease, which can be demonstrated to be tuberculous. Therefore, the difficulty is very great in making the diagnosis between a chronic syphilitic joint disease and a tuberculous joint disease. The acute cases are quite different from the chronic syphilitic joint diseases, and they rapidly get well under treatment; while the chronic cases get well much more slowly, but do get well much more rapidly under immobilization and mercury and iodid of potassium than do cases of ordinary tuberculous joint disease. The diagnosis has to be made by instinct in many cases, instead of by positive clinical facts.

DR. JAMES T. WATKINS, San Francisco: Taken as a whole the paper is important because it points out the danger which even painstaking observers run of mistaking a luetic bone lesion for a tuberculous condition if they put their trust implicitly in the absence of a positive Wassermann reaction. Those of us who see much bone and joint disease must agree with Dr. Fisher that bone and joint syphilis is much more prevalent in childhood than the literature would seem to indicate. Second, of those cases which are clinically luetic, Dr. Fisher finds that 10 per cent. do not give a positive Wassermann reaction. I am of the opinion that to estimate them at 20 per cent. would be to get nearer the mark. Third, of these Wassermann negative syphilitics, those with involvements of the shafts of the bones only present pain worse at night as the one constant symptom. These have, however, definite Roentgen-ray changes. Fourth, in the group which presents joint involvements, the Roentgen-ray changes may be misleading suggesting tuberculosis. Therefore, all you have to go on is limitation of motion and pain, pain which is not relieved by mechanical protection of the involved joint. The only reliable test is the therapeutic one. If one would reduce the teachings of this paper to a sentence, one would

have to go back to the dictum of the pre-Wassermann clinicians and say with them "When in doubt treat for syphilis."

DR. EDWARD HATCH, New Orleans: During the last few years I have seen several cases in adults, some of which came for frank, and some for indefinite joint pain. The diagnosis was made by the Roentgen ray; and in each case, the Wassermann test was negative. In practically all, the luetin test was positive. Therefore, I should like to ask Dr. Fisher whether he has made tests of the luetin reaction, and whether he considers this an aid in the diagnosis.

DR. EDWIN W. RYERSON, Chicago: It is important, in this connection, to remember that some cases with a negative blood Wassermann may give a positive spinal-fluid Wassermann. This is not recognized quite enough, nor is quite enough advantage taken of it. I have seen about ten cases in the last few years in which the blood Wassermann was negative, and the spinal-fluid Wassermann was absolutely positive.

DR. WALTER G. STERN, Cleveland: Let us clinicians not forget that Wassermann stated in his original paper that a negative blood reaction is of no diagnostic or prognostic value, unless the reaction continues negative for as long a period as a year to a year and a half; so that one must not be too hasty in ruling out syphilis on the basis of one or two negative serological examinations.

DR. REGINALD H. SAYRE, New York: I think that the old Scotch verdict, "Not proven," is very applicable to this case; and I only wish to question the writer of the paper in regard to one point. I agree with everything else. This point is that he feels that these cases are not benefited by protection. Now I believe that in a great many cases, it is as wise to give protection to the syphilitic, as well as to the tuberculous joint. I have seen syphilitic hips that went for a considerable period of time with protection and hip splints not undergoing any shortening, and that, when the weight bearing was again permitted, began to telescope. It seems logical, in a soft bone, to relieve it from strain, if you wish to preserve continuity.

DR. C. B. FRANCISCO, Kansas City: In the years 1907-08, at the Hospital for Ruptured and Crippled, before the time of the Wassermann test, in admitting the children we did not label a single case syphilis of the joint, diagnosing these cases as tuberculosis, but I hesitate now to make that diagnosis. I should like to go a point further in these cases, more especially in those involving the bone near the joint, which are very difficult at times to diagnose. Strange to say, some of these cases will get well without antisyphilitic treatment; and you think that you have a tubercular joint, only to have the patient come back, in the course of a few years, with a chronic syphilitic joint somewhere else, proving that the condition was probably syphilis from the start. Nichols says

that 50 per cent. of the cases of latent bone syphilis give negative Wassermann's, and that we should rather rely on the Roentgen ray than on any one other factor for diagnosis. There is one difficulty with the therapeutic test: it will not relieve the endosteal bone changes. Mercury and iodid will relieve the periosteal changes and the gummatus changes, but the endosteal thickening will remain. Another point, advocated particularly in England, is that salvarsan is of no particular value in bone syphilis. Mercury and potassium iodid, in the periosteal and gummatus type should be the treatment of choice.

DR. LEONARD W. ELY, San Francisco: Opinion in regard to bone and joint syphilis has changed. There used to be skepticism concerning the occurrence of joint syphilis in childhood. The essayist has brought out the lack of reliability of the Wassermann test. There is no reliable test for joint syphilis. The Wassermann test, the Roentgen ray, the clinical course, the history, must all be considered; and then we are not certain about a diagnosis. The gross bone changes in syphilis of the joints are exactly the same as those of tuberculosis. The changes in the synovial membrane are, in gross, also the same. The microscopic and histological changes are not absolutely reliable. If we find what we consider a tubercle, we say the joint is tuberculous; but the pathologist tells us that we cannot depend on the presence of giant cells, and what we are wont to regard as the characteristic changes of tuberculosis. The guinea-pig test is the most satisfactory; and yet, we have just had a case in our clinic that we have been working over for the past six months, the diagnosis lying between so-called Legg's (Perthes') disease, syphilis and tuberculosis. The patient went to another clinic and was operated on for giant-cell sarcoma. The tumor was sent to a pathologist, who said that it was probably tuberculosis. The material when injected into a guinea-pig gave a negative tuberculous reaction; and we thought that the case was closed. Later, however, the operator told us that he had administered tuberculin and got a reaction, and that he regards the case now as tuberculosis. Personally, in the absence of the animal test, I regard the therapeutic test as the most reliable.

DR. EMIL S. GEIST, Minneapolis: I have had several cases in my practice in the last few years, in which the diagnosis of bone or joint syphilis was made. The history was positive, the Wassermann reaction was also positive, and the roentgenogram showed definite joint lesions; yet when the therapeutic test was applied, it did not give any results. When the physician, who had correctly diagnosed the case, came in, we told him that we thought we were dealing with tuberculosis or some other bone or joint trouble. Nevertheless, the cases turned out to be syphilitic. It has been my experience that in some of these cases, we must push the treatment to the limit, and that really the therapeutic test had not been tried,

when it had been found wanting in the minds of these men. The point that I would make is that bone and joint syphilis is more resistant to treatment than other forms and I have been accustomed to transfer these cases to the syphilographer, because he has been handling more syphilitic remedies and knows better how to apply them than I.

DR. HENRY LING TAYLOR, New York: Not infrequently, when the Wassermann is negative in the child, it may be positive in one or both parents; this has been found true in several cases lately. It pleased me very much to hear one of the speakers say that the old fashioned mixed treatment is more reliable than salvarsan in bone and joint cases. I have also found this to be the case, and it does not seem to be generally known. Some men think that they are giving antisyphilitic treatment when they give iodid of potassium, but this is a delusion; mercury is the active agent.

DR. ROBERT W. LOVETT, Boston: Most of the remarks have been coincident with my own experience. One point I should like to mention is the stimulation of chronic osteomyelitis by syphilis. I have had cases of chronic osteomyelitis that gave a positive Wassermann reaction and improved under anti-syphilitic treatment. About a year ago I went through some plates with Dr. Post, Professor of Syphilis of Harvard University, who has given great attention to the appearances in bone and joint syphilis. Some of the plates showed very clearly bone syphilis. Some cases that we had diagnosed as osteomyelitis, he thought were characteristic of syphilis. Many of them were old plates.

DR. A. E. HORWITZ, St. Louis: We see a surprising number of these cases in St. Louis, probably because we look for them. In most of these cases the Wassermann is negative, the percentage of negative results being fully 50 per cent.; so we do not, as a rule, rely on this test, but look for other essential points. In the congenital form, there is usually multiple joint involvement; so we have come to rely on this. It is essentially polyarticular not like tuberculosis, with one or two joints involved, but, in most cases quite a number of joints. One strong point is the shaft involvement. In the joint where the involvement occurs, by looking well, we can find some slight involvement in the opposite end of the shaft. If we do not, we find a symmetrical involvement of the opposite limb in the same joint. That has been very striking and very often demonstrated. In spite of negative Wassermann reaction, we can, therefore, make the diagnosis, because of the fact that the disease improves under antisyphilitic treatment. Another point is that in the congenital cases, which are essentially polyarticular, the condition is not entirely articular, but extends into the shaft somewhat; and even in the acquired form of syphilis, wherever there is bone involvement, it also extends into the shaft, and possibly from the shaft to the

joint. So much is this so, that we tried to claim that acquired lues is not an actual joint condition, but an extension from the shaft; while the congenital form is joint involvement proper, extending to the shaft.

DR. ARTHUR L. FISHER, San Francisco: My object in bringing up the subject was to set forth the fact that the Wassermann test is unreliable in two ways: first, that in a large proportion of luetic cases one gets a negative Wassermann; and second, and more important, because of the interpretation given by the profession at large to the Wassermann, that a negative Wassermann means no syphilis. We know that this is not true, and I have tried to bring out the fact that all these patients have been in the hands of competent physicians who, on account of the negative Wassermann, regarded the cases as not luetic. In answer to the remark about the spinal fluid Wassermann, I would say that it is unquestionably a fact that it happens with great frequency that a blood Wassermann is negative, and a spinal fluid Wassermann positive. These cases, however, are usually central nervous system syphilis—tabes or cerebrospinal syphilis; and you get in them the so-called Charcot joints. I have not seen any joint involvement, except these, in such cases. With regard to the protection of the joint, I would say that it does not give relief of symptoms in these cases, and does not tend to a restoration to normal. Of course, if a diseased area is bearing weight it is wise to protect it. I am glad that the subject of the histology of the condition was brought up, because there is a broad general statement that can be made in regard to it; and that is, that without finding the tubercle bacillus, you cannot be sure whether you are dealing with syphilis or tuberculosis. You can usually, if you look at a slide, say, "This is a tubercle" or "This is a gumma"; but you can never be sure, and even an expert pathologist will not usually give a definite diagnosis on this point. Dr. Lovett brought out an interesting point, the difference between syphilis and chronic pyogenic osteomyelitis. We have been coming to believe that when pyogenic osteomyelitis is multiple, it is usually in a syphilitic patient, either congenital or acquired; and you will usually find some evidences of syphilis in the family in these cases.

# ANKYLOSING OPERATIONS ON THE SPINE

A STUDY OF TWO SPECIMENS IN THE LABORATORY \*

LEONARD W. ELY  
SAN FRANCISCO

The two specimens described here were removed at necropsy.

CASE 1 (E113).—The patient was a child of about 5 years, operated on for spinal tuberculosis by Dr. Watkins, with Dr. Ely assisting, five months before death. The cause of death was pulmonary embolism. The operation was a typical Hibbs.

The specimen includes six vertebrae, the two lowest thoracic and four lumbar, one of which (the first lumbar) is badly diseased. No motion can be detected in the operated portion between the spines, but the bodies move a little on each other.

*Sagittal Section.*—The diseased vertebra is crushed into a trapezoid, and its substance is decidedly harder and denser than is that of the other vertebrae, in spite of the fact that anteroposteriorly runs a band of necrotic tissue, so that the two halves (upper and lower) move on each other. This rift in the bone communicates posteriorly with a collection of cheesy material which has pushed the posterior common ligament backward into the spinal canal. The marrow of the affected vertebra appears yellower than that of the others.

The impression one gets in examining the specimen is that too much of the work in the operation has been done above the diseased vertebra, and too little below it. The laminae of the three lowest thoracic vertebrae and of the first two lumbar are united by bone, making of all five a firm bony mass. Of the spinous processes themselves there is no trace. The union is interlaminar, not interspinous.

*Examination* of the stained slide, which includes the diseased vertebra and the vertebra above and that below it. The diseased vertebra is in the form of a blunt wedge with the apex forward. Its middle portion is worst involved; in fact, the diseased area divides the vertebra into an upper and lower

\* From the Laboratory of Surgical Pathology of Leland Stanford Junior School of Medicine.

portion, and the products of inflammation bulge out posteriorly so as to narrow somewhat the lumen of the spinal canal. The structure of the diseased vertebra is different from that of the vertebrae above and below. It is more transparent, and the contrast between its trabeculae and its marrow is sharper.

*Histology.*—The upper and lower vertebrae are normal. The marrow in each is lymphoid.

The middle vertebra is badly diseased throughout most of its extent. A small strip of approximately normal lymphoid marrow runs along the lower margin of the vertebra close to the fibrocartilage. The rest of the marrow is badly diseased. Much of it is fibrous marrow, very vascular; much of it is tuberculous. Necrosis of the tuberculous areas is well advanced. Many of the trabeculae are dead, and areas of calcification form a prominent feature. The whole middle portion of the vertebra has broken down, and is represented by a transverse band of necrotic material in which are many areas of calcification. The trabeculae here show well marked rarefying osteitis and are practically all dead. The tuberculous granulations have burst through, have consumed the thin cortex of bone posteriorly, and have formed an abscess beneath the posterior ligament. The abscess contains cheesy granulations, with many areas of calcification, many dead bone trabeculae, and one small sequestrum just discernible by the naked eye. Communicating with the diseased mass, and anterior to the disk between the diseased vertebra and that above it, is another somewhat smaller abscess cavity containing tuberculous granulations, and much necrotic and calcified material. It looks as if it had been formed by the squeezing out of material by pressure on the diseased vertebra. The lamina of the diseased vertebra is united to that of the one above it by bone, and this is separated from the next one above it by a very narrow interval of fibrous tissue in which bone is forming. The lamina of the diseased vertebra is separated from that of the one below it by fibrous tissue, in which no bone formation is taking place. (Evidently at the line of section the band of bony union mentioned above has not been included.)

We have, then, as the result of the operation, bony union in the operated area, and a tuberculous process still active in the body of the vertebra.

This specimen, besides its relation to an ankylosing operation, throws light on a point which has been up for discussion before this section for the past two years. You will remember that Mr. Fraser maintained that tuberculosis started in the synovial membrane, and that circulating toxins caused the marrow in the

**A**

Fig. 1—Hibbs operation. Photograph of stained slide, showing diseased vertebra between two sound ones. Bony union at A. Natural size.

**Fig. 2.—Albee operation.** Posterior aspect of specimen showing graft in place.

**Fig. 3.—Albee operation.** Lateral aspect of specimen, the graft on the left, with a specimen removed at *a* for study.

**Fig. 4.—Albee operation.** Bone graft in place. The graft appears as a cap of dense bone on the spongy bone of the spinous process. Photograph of the stained slide, enlarged four diameters.

**Fig. 5.—Albee operation.** Photomicrograph of portion of graft, showing many empty lacunae, and a blood vessel entering the bone. Note difference in staining of bone

adjacent bone to change from lymphoid to fatty or myxomatous marrow; not until then could the disease gain a foothold in the bone. From which joint could the extensive involvement of this vertebra proceed? How is it possible that one vertebra could be so badly diseased, while the vertebra on the other side of the offending articulation escapes entirely? Mr. Fraser, I believe, has confused cause and effect. The fatty and "fibromyxomatous" marrow is not the precursor of marrow invasion, but the sequel. If not the only determining factor in the location of tuberculosis in the bone, at least by far the most important one is the presence of lymphoid marrow. No lymphoid marrow, no tuberculosis.

CASE 2 (E 127).—Lumbar spine on which an Albee operation had been performed two years previously by Dr. McChesney. Apparently firm union had taken place. A spondylolisthesis was present, accounting for the paralysis of the lower extremities. A large cheesy mass was present in the body of the fourth lumbar vertebra, well walled off.

Three and a half years previous to death, the left hip had been resected for tuberculosis, and about one and a half years later, an Albee operation had been done on the spine by Dr. McChesney. At about the same time the internal genitals had been removed. The patient had been admitted to the hospital in coma and died two days after admission. Paralysis of the lower extremities was said to have been present for some time.

*Anatomic Diagnosis at Necropsy* (Dr. Ophüls).—Tuberculosis of intestinal tract, primary tuberculosis of lymph glands, mesenteric, healed. Tuberculosis of spine, lumbar region. Operation, Albee. Tuberculosis of hip (healed). Bronchopneumonia. Cirrhosis of liver. Adiposity general. Liver fatty. Heart, fatty. Gastritis, chronic.

The specimen consists of the spines of the lumbar vertebrae, the last four firmly joined by a thick bridge of bone, the graft. The graft is firmly united to each spine, so that its exact limits cannot be distinguished, only a ridge where it joins the spines—an irregularity. The soft tissues were firmly attached to the graft as well as to the spines, and their dissection was quite difficult. Dr. McChesney is strongly of the opinion that the graft has grown in thickness since insertion. Anteroposterior section of graft, and the embedding portion of the spine of first lumbar vertebra were made for study.

Section of a piece of the body of the fourth lumbar vertebra, including the wall of the abscess, includes bone and intervertebral disk. The bone trabeculae stain very poorly. Their margins take the eosin stain well, but not the rest of them. The bone marrow is lymphoid and fatty. None of it is tuberculous. The wall of the abscess is evident—a small fringe of necrotic material, well encapsulated by fibrous tissue. The process is in the stage of healing.

*Histology.*—The graft appears as a cap of dense bone on the end of the spongy bone of the spinous process. The cortical bone of the latter, as well as its trabeculae, are directly continuous with the bony tissue of the former. The spinous process shows normal spongy bone with lymphoid marrow, and a rather thin cortex on the sides.

The graft at its surface, that is, directly under the periosteum, presents a layer of what is presumably new bone, staining deeply with hematoxylin. Its cells can be seen in their lacunae and stain well. Here and there blood vessels penetrate this superficial layer, and small blood vessels are present through the graft.

Immediately under the superficial layer is a stratum, some of which seems living and some dead. In a general way the live bone is immediately adjacent to the haversian canals, and the dead bone fills in the spaces among the haversian systems, but this rule is only a general one. The rest of the graft consists of dense bone, whose cells stain fairly well for the most part, though they do not fill the lacunae. The marrow is normal fatty. No rarefying osteitis is present.

We have here, then, a firmly united graft after two years, composed of fairly normal bone with fatty marrow, containing blood vessels. At the surface is apparently new bone. The disease in the body of the vertebra is in the stage of healing.

Apparently it is impossible to tell with certainty dead from living bone under the microscope. In certain of the slides most of the cells are missing from the lacunae, and the bone might be pronounced dead; but if it were dead it would hardly resist absorption for two years; blood vessels probably would not be seen in its meshes, nor would ordinary fatty marrow be seen in it.

Besides these two specimens, I have been fortunate in seeing one other secondary operation, and of doing one myself. The former was done on account of the

persistence of pain and discomfort, and of increase of deformity, following a Hibbs operation. The laminae in the area of disease were found fused for the most part, but a joint still persisted in one or two places in the operated area. A graft was removed from the tibia and was sewn tightly against the denuded laminae. The result is described as satisfactory.

The second case was also one in which a Hibbs operation had been attempted, and in which pain persisted and deformity increased. The spines were absent, and no indication of union was present among the laminae. The vertebrae could be seen to move freely on one another during respiration. The treatment was by tibial grafts sewn tightly to the denuded laminae. The result ten months later was excellent. All symptoms of active disease had ceased, bony union apparently had taken place, and the marked kyphosis present previously seemed, by tracings, to have lessened.

One other fact needs mention. In a rather small experience in spinal ankylosing operations, I have lost two patients on the table. In neither was a necropsy done. A colleague has recently told me of another fatality.

Personally, I am strongly in favor of these operations in spinal tuberculosis, and regard them as curative in a formerly incurable disease; but their dangers should not be minimized. I regard my two fatalities as due to the anesthetic, and since the occurrence of the second one have never done the operation without a skilled anesthetist.

I am indebted to the courtesy of Dr. James T. Watkins for the first specimen, and of Dr. William Ophüls for the second.

Lane Hospital.

#### ABSTRACT OF DISCUSSION

DR. RUSSELL A. HIBBS, New York: There is no question that we can get ankylosis of the spine by operative procedure, and I have no hesitation in saying that the earlier

it is done, the better for the patient. It has been said by some that the cases to be operated on are those that are not doing well. Those who have had experience with Pott's disease know that it is very difficult to decide which cases are doing well over a long period, and which are not; and I do not believe that these operations are serious. I therefore think it is better to operate, and my associates have done three hundred and fifty of them without any operative mortality. We have always had a good anesthetist; and, as Dr. Ely says, this is very important. Regarding the details of the operation: The success of the procedure depends primarily on the dissection. What we wish to accomplish is fusion of the bone, and not splinting of the vertebrae. We must eliminate motion. We must, therefore, eliminate the articulation, and, hence, we must fuse the bones that participate in the formation of the articulation. In the spine we have a large area of perfectly healthy bone to operate on. The posterior aspects of the vertebrae are, as a rule, healthy, and may be fused with certainty if a thorough dissection is made at operation.

DR. REGINALD H. SAYRE, New York: I have some cases under observation at the present time that show that a bone splint does not under all conditions remain, but sometimes becomes absorbed. I have three patients, two adults and one child, in whom tibial splints were placed by others. In the small boy I have had roentgenograms made each month, and have been very much interested to note the gradual disappearance of this bone splint. At first the child was purposely left without protection; but later, after six months of watchful watching, he was placed on a board. After about a year or so, he got a perfectly good spine, but no sooner than would have been the case without operation. The two adults who had been operated on before coming under my observation, were unable to walk, except by supporting themselves by placing their hands on their knees; and Roentgen ray examination showed no trace of a bone splint. I have no doubt that a bone splint had been put there at some time in the past, because the scars looked as if that had been done, and because the operations were done by gentlemen of experience. I have no doubt also, that it was a well done operation in each case, but, for some reason, the bone did not form a bridge, as in the specimen passed around by Dr. Ely. The bone had disappeared, and there was recurrence of the symptoms for which, I presume, the operation was done.

DR. JAMES T. WATKINS, San Francisco: We have done between fifty and sixty of these operations at the Children's Hospital, approximately an equal number of Hibbs and Albee operations. The patients seem to get well with about an equal degree of assurance following either operation. I think that on the whole I prefer the Hibbs operation. Certainly the Albee is quicker to do. Dr. Hibbs says that in the speci-

men being passed around I did not fuse my articular processes. However, that is easily explained. This refinement of the operation did not appear in Dr. Hibbs' earlier publications, and I had not heard of it at the time I did this operation. Still my earlier cases got well without it. This child, you know, died of lung condition six months after operation. In this specimen most exact fusion between the adjacent spinous processes and between the adjacent laminae has taken place. There is no evidence of bony absorption. I cannot explain this apparent discrepancy. I have had occasion once to operate again on a patient who had been operated on a year previously by the Hibbs method, and I have seen the specimen which Dr. Sherman removed from another Hibbs case in the course of a laminectomy. Macroscopically the spines had been transmuted into a broad, flat, thin plate of bone more nearly resembling a sternum than anything else.

DR. EDWIN W. RYERSON, Chicago: It is undoubtedly true that we can obtain bony fusion of the vertebrae by either of these methods. The choice of the operation is not on a very well defined basis. My own impression is that if I think the patient needs a rapid operation, I can do the Albee operation a good deal faster than I can properly do the Hibbs operation. The first few of the latter operations that I did were done before I saw Dr. Hibbs do this operation; and after I had seen his careful way of doing it I knew why my first two cases did not have as good a result as I thought they should have had. I find that in younger children we must protect the spine for a longer time than I at first believed necessary. I have seen, now, a good many of the late results of both the Hibbs and the Albee operations that I have performed. A number of the younger children on whom I did either kind have not been protected long enough, with the result that an increase in kyphosis has taken place. We should protect such patients for a long time afterward. In regard to what Dr. Sayre says of the disappearance of the Albee grafts in some of the younger patients, it is not always easy to see in the roentgenogram the shadow of the graft. I have cut down on one case in which the Roentgenogram did not show the bone, only to find that there was bony ankylosis. It was slightly flexible; and the reason that the boy was reoperated was that at the top of the splinted area three inches above the diseased area, a new focus of tuberculosis had appeared. I put in a new graft, going many vertebrae higher. The splint in the Albee operation is flexible, in children, and the patient should have protection until it is no longer so. How long this may be, I do not know. The most striking case that I have had is that of a girl on whom I operated in 1912. A large psoas abscess which she had at operation has disappeared, and there are no symptoms whatever. You can feel a massive bone formation in the spine, from the splint, and the deformity is thought

to be less than it was a few months after the operation. She had careful conservative treatment by braces for a year before operation, but the condition grew worse. She is now completely cured, four years after the operation.

DR. J. T. RUGH, Philadelphia: One thing about this operation that has impressed me the most strongly is the very low mortality. In a series of eighty cases, I have lost but one patient. In that case, when I was through, the anesthetist could tell me every step of the operation. The patient had died on account of the ether.

DR. R. A. HIBBS, New York: We should give these children and adults very careful protective treatment after operation. It is a great mistake to assume that you are eliminating the disease so quickly. We treat the cases just as if they had not been operated on, so far as protection is concerned. Children are treated for a year or eighteen months and adults, six months to a year. There have been many children whose parents have been disappointed because they were operated on and let go, without proper after care. I want to protest very strongly against that.

DR. LEONARD W. ELY, San Francisco: I must differ with Dr. Watkins' contention. The section is taken approximately directly through the middle, where the base of the spinous process would be; and here there is little, if any, bony union. At the side one sees in the gross specimen the union of the laminae. When you cut off the spinous process and turn it down, probably that spinous process is doomed. Without bringing up this subject of the ultimate fate of a bone that is grafted, I would say that that spinous process may be likened to a man who is dead from some accident, but who, with artificial means of respiration is brought back to life. That life cannot be supplied to the spinous process except by contact with another bone or connection with another bone by periosteum. What Dr. Watkins says about the difficulty of the Hibbs operation I should be inclined to stand by and accentuate. Whenever I get an opportunity, I go to see the originator of the operation operate. The beauty of the dissection and the carefulness with which Dr. Hibbs does the operation seem to be the determining factors in the results obtained.

## RESULTS OF RESEARCH ON CONDITIONS AFFECTING POSTURE

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Much has been said and well said on the importance for health and efficiency of straight standing and sitting, and on the deleterious effect on posture of weakness, poor health, overwork and certain types of physique.

The effect of extrinsic conditions, such as clothing, furniture and certain features of family, school and industrial life on habitual posture, are also important. In order to study such matters more closely and to improve personal and environmental conditions affecting posture, the American Posture League was organized three years ago by a group of physicians and educators, and this paper aims to present some of the results of work done by its technical committees, or officially approved by them.

Broadly speaking, a good basic standing posture is one in which the different segments of the body, head, neck, chest, lower trunk, and legs, are balanced nearly vertically on each other like a column with its base, shaft and capital.

The posture of the standing figure may be tested in side view by comparison with a vertical line passing through the ear. In order to illustrate good posture and contrast it with a relaxed and with an exaggerated posture, the league has issued two wall charts of a girl and boy, respectively, illustrating the three attitudes in side view. These charts have been widely used in class rooms, physicians' offices and families, and have proved their practical value.

A new method of recording posture is furnished by the Mosher-Lesley schematograph, a camera-like apparatus which reflects the figure much reduced in size on a horizontal glass plate over which a sheet of tracing paper is stretched. On this the outlines of the figure may be traced in front, side and rear views, if desired, and preserved for record or comparison with subsequent tracings. The outline of the figure may also be traced in other postures.

The effect of various postures on the position of the internal organs, especially the stomach and colon, has been studied fluoroscopically by one of the league's technical committees, which reported that in normal subjects standing, the fatigue posture, and also the lordosis posture lowered the abdominal organs; the erect posture invariably raised the organs from 1 to 3 inches. Breathing with chest up, especially with contraction of the abdominal muscles, raised the organs 1 to 5 or 6 inches. Ordinary deep breathing had little effect on the organs. The recumbent posture usually elevated the organs from 1 to 4 inches.

The conclusions of the league's technical committee on shoes are of general interest, and it seems to us of great importance. A preliminary investigation failed to show any exact anatomic basis for the prevailing shapes of lasts, and it was decided that a study to determine whether average feet were of one or several types was necessary before the subject of shoes could be intelligently attacked. It was also seen that the ground plan of the foot should be a determining factor in the ground plan of the shoe. A call was sent out to the membership of the league for tracings of average feet, with other data, and 1,422 answers were received from various parts of the United States, India and China. In order to determine the relation of the front of the foot tracing to the heel, the more stable part, the tracing of the heel was bisected longitudinally and the axis thus found was prolonged to the front of

the foot. In order to do this conveniently, a simple instrument called a foot meter was devised. This consists of a piece of transparent celluloid, 7 by  $13\frac{1}{2}$  inches, on which a central line is drawn, with parallel lines at equal distances on either side giving the distance in quarter inches from the central line. This central line is so applied to a foot outline as to bisect the heel, when the distances of the outline at the ball from this axis on the outer and inner side may be read off from the foot meter.

Studied in this way, the foot tracings were divisible into three types: (1) those in which the heel axis prolonged forward divided the ball equally to within less than a quarter of an inch; these were called straight feet. In other tracings (2) the larger part of the foot at its widest part fell to the outer side of this axis; these were called outflared feet. In still a third class of tracings (3) the larger distance from the heel axis lay to the inner side; these were called inflared feet.

In 1,131 tracings of American adults, dropping fractions, the following percentages were shown: straight feet, 30 per cent.; inflared feet, 14 per cent.; outflared feet, 56 per cent. The percentage did not greatly differ in men and women. We have nearly a hundred tracings of American children under 11, but are collecting more, especially of the younger ages, for special study.

One hundred and seventy tracings of the feet of Oriental adults from China and India, many of whom have never worn shoes, showed the three types of straight, outflared and inflared feet as in shoe-wearing Americans, though the percentages of the three classes are different. Leaving out fractions, the 170 were divided as follows: straight feet, 36 per cent.; inflared feet, 38 per cent.; outflared feet, 26 per cent.

A further study of these tracings, especially as to the effects of barefootedness and laborious occupations

on the type, is now in progress. Since the ground plan of the foot may be straight, inflared, or outflared, it follows that no one type of shoe will fit all feet. Shoes are now being constructed over lasts of the three types, designed by a technical committee of the American Posture League, and will soon be on the market. These shoes not only have been designed with reference to the anatomy of the foot, but also have been made as light and attractive as was compatible with their intended use.

Other technical committees have laid down principles and effected reforms in the construction of ready made coats, and in garment suspension. It was found that many ready made coats for men and boys were too narrow in front and too loose behind because made over a round-back model. Such coats virtually compel poor posture. This was taken up with a large manufacturer, and the coats were remodeled to proper shape.

The weight of garments should be suspended from the shoulders near the neck, and from the pelvis above the hips; the shoulder tips and waist should not bear the weight of clothing. Waists and garters have been designed on these principles.

The Furniture Committee, having no apposite anatomic data, sent out a questionnaire to members on certain measurements of the adult clothed figure, and based its work on chairs and seats on a study of these measurements and other experimental data. In hygienic seating the feet, thighs, pelvis and spine are comfortably supported in proper relation to each other. Pressure on the popliteal region, and outer part of the scapulae and shoulders is avoided. Support to the back is given mainly in the upper sacral region, and lower half of the dorsal region. The chair floor is shaped to distribute pressure, and to prevent the pelvis sliding forward. A large space is provided at the lower part of the chair back, so that the buttocks may not be pushed forward. The chair back should

be flat from side to side, or only slightly hollowed, so that the shoulders and scapulae may not be pushed forward. The slope of the back and other features vary with the use for which the seat is designed, the back being more reclined in chairs designed for resting.

Seats have been worked out for the new subway cars of the Brooklyn Rapid Transit Company and are now in use. A standard movable school chair and desk have been remodeled and have given great satisfaction in use. Kindergarten and vocational chairs have been designed, and several models of office chairs have been remodeled on scientific lines. A child's seat for baby-carriage and automobile has been designed from anatomic measurements.

Reading, writing and drawing on a flat surface exert a pernicious influence on posture and often produce eye strain. When the book or drawing board is held at a moderate slope from the vertical, the easel position, the posture is improved and eye strain relieved. An adjustable book rest has been devised, which holds the book or drawing board at the angle of choice and at the proper height.

A design for a sloped library table for reading has just been sent in for the league's inspection. Such tables have been in successful use in the children's department of the Cleveland Public Library.

Much information and material tending to greater comfort and convenience and the betterment of posture conditions are being continually presented for the consideration of the league, which acts as a clearing house for all such matters. Material officially approved bears the league's label.

The foregoing is a very brief summary of a few of the things actually accomplished by the different technical committees, and the interest and scope of the work are constantly increasing.

The scientific standardizing of wearing apparel, furniture and the various appliances used by the worker makes a special appeal to the orthopedic surgeon, but

should also interest the practicing physician and the general public.

The league's scientific exhibit at this meeting shows the scope and quality of the work already done better than any description. The cooperation of all in this work whose benefits are shared by all is cordially invited.

125 West Fifty-Eighth Street.

#### ABSTRACT OF DISCUSSION

**DR. JOEL E. GOLDTHWAIT**, Boston: To mold the human body is important if we are to develop the best efficiency of the individual. If we allow the increasing number of slender individuals to grow up as they are, we shall have an increasing number of men and women to stand as the figure that Dr. Taylor showed. You can see hundreds of them. No one needs to be a physician to glance at such a figure and know that it is not a healthy body and not an efficient creature. If we are to treat these people we must appreciate the different anatomic forms that make it possible for one person having one type of back, and another person another; and we must try to find out the cause of the difficulty from which each suffers. If we think of our patients in that way we can do much to help them. We can visit factories where people are employed; we can show them how to arrange things better. Not only should we see that proper seats are provided, but we should also see that the people using them understand how to adjust them properly themselves. Then there would be less back-ache and pulmonary disease, which must come primarily from the fact that the body is so used, that the parts cannot work without strain.

**DR. MALCOLM C. ROSE**, New York: For a number of years, I have taken the simple precaution of asking people to take two minutes' exercise night and morning in their bed room, without clothing. The object of not having clothing on is to give freedom of movement and that they may see how they are holding their body. Tell them to put their knees back; it will bring out the center of the chest; tell them to take two minutes' exercise in the room, and they will tell you within a short time how they have improved in general feeling the way they carry themselves.

**DR. ELIZA M. MOSHER**, Brooklyn, N. Y.: The relation of habits of posture to health is much more intimate than is usually supposed. Two bad habits of posture are the "sidewise slouch" and the "heel postures." We all recognize the importance of free rib movement, especially that which maintains a constant interchange of gases at the apices of the lungs. The fact has been established that tuberculosis usually

**Fig. 1.—Standing postures.**



**Fig. 2.—The Mosher Lesley schematograph.**

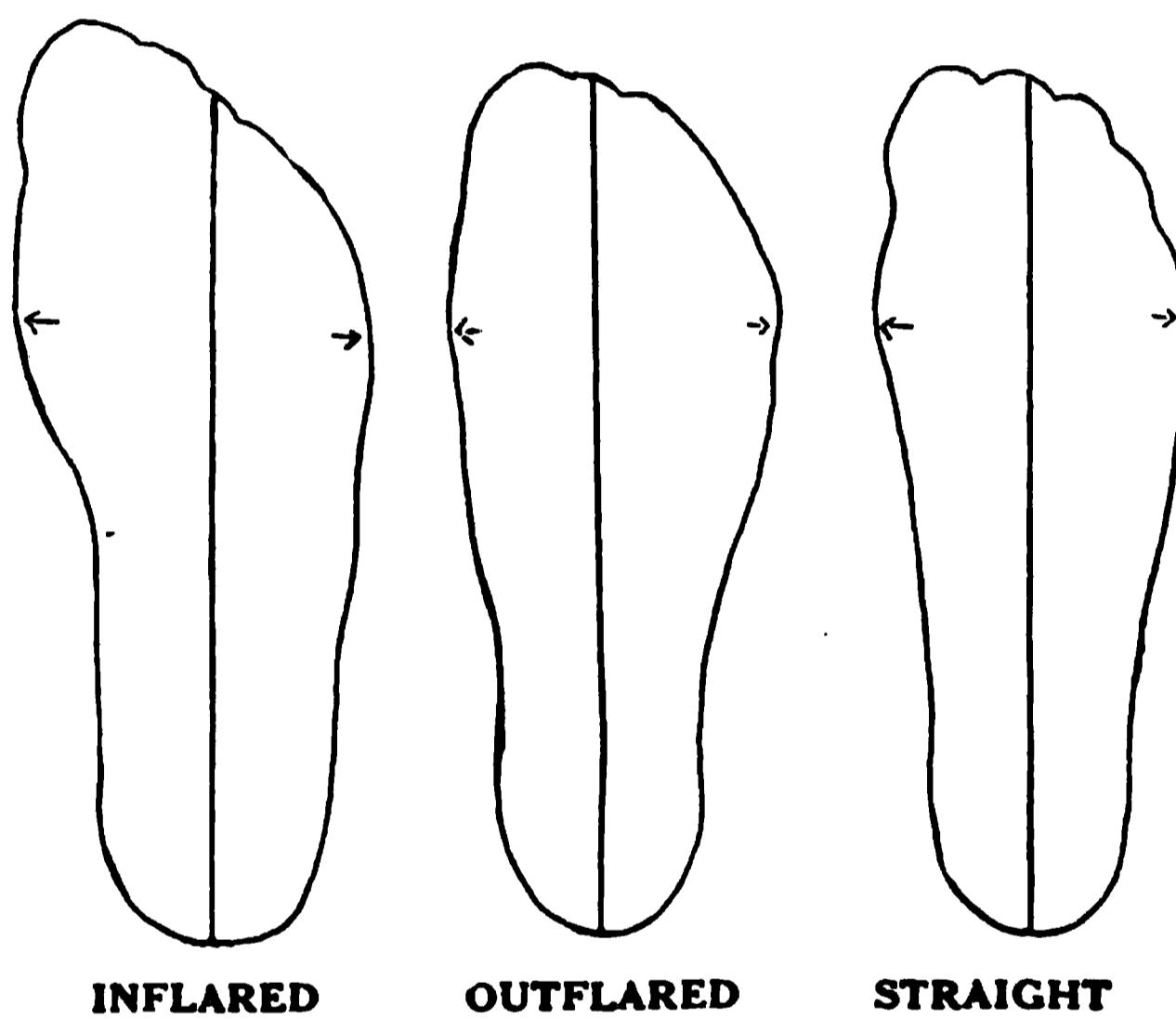


Fig. 3.—The three types of feet established by studies of the American Posture League.

Fig. 4.—Anatomic subway car seat.

Fig. 5.—The rest right waist.

*Fig. 6.—Anatomic kindergarten chair.*



begins at the apex of the lung in which from any cause there is lowered movement of tidal air during the daily activities of life. The "sidewise slouch" posture can easily be shown to be one that mechanically limits rib movement on one side of the chest, especially in its upper part. It happens in this wise: the lax everted leg, instead of a support, becomes a weight which drags the pelvis down; lowering of the hip on one side means a proportional elevation of the opposite hip. This change in the pedestal of the trunk would unbalance the body if other weights were not moved over to enable it to regain its equilibrium. The weights moved are the shoulder and arm of the opposite side and generally the head. In doing this the spine assumes a long lateral curve with its convexity toward the high hip and low shoulder. These changes in the shape of the bony skeleton necessarily cause approximation of the ribs on the side of the supporting leg—which is almost invariably the right, and separates the ribs on the side of the low hip and elevated shoulder. With ribs thus posturally separated the inspiratory muscles are helpless (to raise them) as also are the muscles of expiration to draw them down. Hence the movement of tidal air is inhibited more or less completely. In an examination of a large number of tubercular patients I have almost invariably found the "slouch" habit of posture present and the disease beginning on the side of the low hip and high shoulder. While the so-called "heel posture" produces round shoulders and flat chest it does not greatly interfere with the movement of air in the chest. Its malign influence is exerted on the abdomen and its contents. The shutting down of the ribs on the upper abdomen shortens the distance between sternum and pubis, thus lessening the activity of the abdominal muscles and crowding the viscera downward. This usually produces enteroptosis sooner or later with the setting free of its fateful brood to injure the body in all its parts. The American Posture League bespeaks the cooperation of all physicians in its efforts to correct and standardize the things in our environment that tend to produce incorrect habits of posture and to measurably improve public health thereby.

DR. E. S. EVERHARD, Dayton, Ohio: What constitutes correct posture has been largely a matter of individual opinion. Each orthopedic surgeon, each director of physical culture and each general practitioner interested in it, has his own idea. In the correct posture a line through the head and neck in front of the ear is vertical; one from the middle of the shoulder down through the trunk is vertical; and one from the middle of the trunk through the legs is vertical. This is known as the vertical line test for posture. It is valuable because it gives a standard. There are three types of feet, the "inflared," the "outflared" and the straight. If we put an "inflared" foot into an "outflared" shoe, we cannot expect good results.

DR. ROLAND MEISENBACH, Buffalo: To establish the correct posture is by no means a simple problem. The work of establishing correct attitude, as Dr. Taylor is doing, is certainly commendable. Faulty attitude, like ptosis, cannot be corrected dogmatically. There are several reasons for this. In the first place, the variation in the anatomy of individuals must be taken into consideration; also the frequent occurrence of disease, as, for instance, rickets, especially in children, must be considered; likewise the flat back and the lordotic back. In regard to the sitting posture, I believe the time will come when we will have to conform our chairs to the individual rather than the individual to the chair. This is especially true in schools, and in special schools.

DR. S. A. KNOFF, New York: People who are subject to tuberculosis should not only be taught how to walk straight but how to breathe properly and deeply. I should like to see children enabled to sit comfortably, particularly in schools, on properly adjusted seats and at desks of the right height, and above all, they should not be obliged to sit quietly without moving for too long a time. It is an awful task for a youngster to sit for three quarters of an hour without wriggling. It is very sad to see so many children become subject to tuberculosis who have no tendency either by heredity or by reason of early infection, but because they have been confined altogether too long in badly aired and often overheated school rooms, and obliged to sit in an unnatural posture and with but a few minutes recess and often only in a dusty indoor playroom. Let it be understood that, no matter how good the posture, if it is maintained too long without change and the air is not fresh, good, and pure, it cannot be productive of good. To still further develop good, sound lungs and increase the vigor of the children, I would like to see singing, recitation, botany and geology taught out of doors as much as possible. I firmly believe that in this way you can do much to diminish tuberculosis in childhood. A recent study on the period of life at which infection from tuberculosis takes place most frequently, has convinced me more than ever that if we wish to combat tuberculosis successfully we must begin to prevent and cure it during childhood. If we do this at the right time, at the right place, and in the proper manner, we cannot fail to be successful.

DR. HENRY LING TAYLOR, New York: This is merely one aspect of the great movement for better hygiene. I am quite in sympathy with what Dr. Knopf said. School hygiene and industrial hygiene are both in great need of reformation, but we cannot expect, by simply giving an employee a good chair, to effect a hygienic reformation in him, when he is, perhaps, underfed and underpaid.

## MECHANICAL DERANGEMENTS OF THE KNEE JOINT\*

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Mechanical derangements of the knee joint are relatively common and may be due to either extrinsic causes such as exostoses, or to intrinsic causes such as fractured internal semilunar cartilage. It is to the latter, which are the most difficult to diagnose, that attention will be drawn in this paper.

### ANATOMY

The knee joint is a hinge joint. While nature was apparently most lax in providing bony reinforcements to the knee, she has been most ingenious in furnishing ligaments strong enough to take up the strains imposed. In front is the anterior or big patellar ligament. This has a ligamentous or tendinous attachment below and a muscular attachment above. Its action as a true ligament, and therefore is not very great. On the inner side is the internal lateral ligament, short, strong and fan shaped, with its narrow part downward, and having its deep portion intimately associated with the capsule and the internal semilunar cartilage. The deep fibers, being short, keep the internal semilunar close to the condyles of the femur. On the outer side the external lateral ligament extends from the external tuberosity of the femur to the head of the fibula, splitting the tendon of the biceps in its course. This ligament has two divisions, a weak posterior part and a strong anterior part. It is separated from the capsule of the joint by the popliteus tendon and the bursa found there.

\* From the Mayo Clinic.

The two lateral ligaments are the chief agents in providing against lateral mobility; the internal lateral preventing the knee from bending outward, and the external lateral preventing the knee from bending inward. The rounded ends of the femur are buttressed, as it were, by the internal and external semilunar cartilages, and thus the lateral ligaments are aided in their function (Fig. 1).

The internal semilunar cartilage forms a large segment of a circle and is less movable than the external. Posteriorly it is firmly attached just in front of the posterior crucial ligament. Anteriorly it is less firmly attached in front of the anterior crucial ligament. Internally it has a firm attachment to the lateral ligament and a somewhat weak attachment to the tibia by the coronary ligament.

The external semilunar cartilage forms a smaller segment of a circle. Occasionally it is nearly a complete circle, there being only a small opening against the tibial spine, as in three of the 150 specimens examined by Tenney.<sup>1</sup> The external semilunar is fixed anteriorly in front of the tibial spine, and posteriorly to the tibial spine between the tubercles, giving a strong slip to the posterior crucial ligament. The attachments to the external lateral ligaments and the tibia are very weak. The semilunar bodies are spoken of as being cartilaginous. In reality, they are fibrocartilaginous, the thick convex part being largely fibrous tissue, and only the inner concave portion cartilaginous. When this cartilaginous border is injured, small pieces of cartilage may become separated and loose. The fibrous tissue is arranged transversely and longitudinally. The longitudinal fibers may continue anteriorly across to the opposite cartilage, forming the transverse ligament—an insignificant structure. At the convex borders, the transverse fibers blend with the capsule. The coronary ligaments are formed by

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1. Tenney, B.: The Anatomy and Surgery of the Internal Derangements of the Knee Joint, Ann. Surg., 1904, xi, 1.

these fibers below and are really only the portion of the capsule between the semilunars and the tibia.

The anterior and posterior crucial ligaments are two very important internal ligaments. The anterior arises from the front of the spine of the tibia near the anterior extremity of the external semilunar cartilage and courses upward, outward and backward to the inner side of the outer condyle of the femur. The posterior arises from the back of the groove on the posterior side of the top of the tibia and from its outer border, leaving the floor of the groove and the transverse piece of the spine of the tibia free and covered by synovial membrane. Here it is closely connected with the external semilunar cartilage and runs forward, upward and a little inward to the front of the outer side of the inner condyle of the femur and of the intercondylar notch (Piersol<sup>2</sup>). These ligaments greatly aid in the stability of the joint. Griffiths<sup>3</sup> states that if the internal or external lateral ligament is divided and lateral bending is attempted with the knee extended, the bending allowed is considerable, but if the same is attempted with the knee in the flexed position no bending is allowed laterally. He concludes, therefore, that inward bending of the knee joint is prevented in the extended position by the internal lateral ligament, and in the flexed position by the crucials. In flexion the relaxation of the internal lateral ligament allows some rotation. With the knee partially flexed, extension may pull on the anterior or upper part of the internal lateral ligament and thus make some traction directly on the internal semilunar cartilage, there being a few fibers of the quadriceps inserted there. This may explain why the anterior extremity of this cartilage occasionally becomes caught and ripped. Jones<sup>4</sup> says experiments show that hyperextension of the

2. Piersol, G. A.: Human Anatomy, Ed. 4, Philadelphia, J. B. Lippincott Company, 1913, i, 404.

3. Griffiths, J.: Observations upon Injuries to the Internal Lateral Ligament and to the Internal Semilunar Cartilage of the Knee Joint, Brit. Med. Jour., 1900, ii, 1171.

4. Jones, R.: Notes on Derangements of the Knee, Ann. Surg., 1909, L, 969.

knee is prevented by (1) the posterior crucial, (2) the anterior crucial, (3) the internal lateral ligament, (4) the external lateral ligament, and that increased extension is secured as one after another of these is divided. Internal rotation is limited by the internal lateral ligament and the anterior crucial. In external rotation the tibia may slip slightly forward on the femur but is stopped by the anterior crucial. On internal rotation the tibia may slip back a little but is stopped by the posterior crucial.

Mechanical derangements produced by intrinsic causes will be considered under the following heads:

1. Semilunar cartilages.

2. Loose bodies:

(a) Of intrinsic origin—chondral and osteochondral bodies.

(b) Of extrinsic origin—foreign bodies.

3. Synovial fringes.

4. Crucial ligaments.

#### DERANGEMENTS DUE TO THE SEMILUNAR CARTILAGES

In the English medical literature there are many reports of large series of cases of damage to the semilunar cartilages, but those reported in the American literature are few. This is accounted for largely, I believe, by the fact that the English, as a class, participate much more freely in vigorous pastimes such as football, Rugby, tennis, hockey, etc., than do Americans. In America the clerk or laboring man seldom indulges in such pastimes, while in England he participates in them freely.

As stated previously, when the knee joint is partially flexed a little lateral mobility is permitted. This is due to the fact that the internal lateral ligament is relaxed. As it slacks, however, the crucial ligaments take up their duties so that when the knee is at right angles, the lateral mobility is checked. From 25 to 90 degrees' flexion is an arc of weakness, and it is in this arc that damage to the internal semilunar is most frequently

inflicted. According to Jones,<sup>5</sup> the most frequent cause of injury to the internal meniscus is strain thrown on the internal lateral ligament when the tibia is rotated outward while the knee is flexed. In rare instances he has known it to occur when the knee was extended; but, as emphasized by Lane,<sup>6</sup> the internal fibrocartilage is injured in such cases only by great force. In extension, the internal lateral ligament is taut and performing its function, and it must be torn before the internal semilunar fibrocartilage can be displaced. In moderate flexion the crucials are not in a position to maintain stability, and the internal lateral ligament being slightly relaxed, some mobility of the internal semilunar is allowed. On attempted extension there may be a slight pull on the anterior extremity of the semilunar cartilage by the prolongation of the quadriceps muscle inserted into that part of the capsule, and the cartilage may be caught between the joint surfaces and torn loose or possibly fractured as the leg is straightened. Martin<sup>7</sup> states that damage to the internal semilunar is common among coal miners who stand with the knees more or less flexed in low seams (4 by 4½ feet) in the mines. A review of our case histories has demonstrated that in the majority of instances the accident occurred with the leg partially flexed, the foot abducted and rotated outward, and force applied which caused the tibia to be rotated outward or the femur to be rotated inward, depending on whether the force was applied above or below the plane of the knee. Locking of the joint is followed by effusion. The pain is often so severe as to make the patient cry out and fall to the ground, grasping the knee with both hands. It is usually most severe at the primary locking, and lessens as the locking becomes more fre-

5. Jones, R.: Internal Derangements of the Knee, *Lancet*, London, 1914, ii, 297.

6. Lane, W. A.: Some of the Common Injuries of the Knee Joint and Their Consequences, *Brit. Med. Jour.*, 1911, i, 537.

7. Martin, A. M.: Discussion on the Diagnosis and Treatment of Injuries of the Knee Joint Other than Fractures and Dislocations, *Brit. Med. Jour.*, 1913, ii, 1070.

quent, until by some patients the pain is complained of less than the mechanical obstruction blocking the extension of the leg. The effusion may be considerable following the early locking, but as the lockings become more frequent the joint seems to accustom itself to the condition, and very little if any appreciable amount is noted. In some cases the locking may not be distinct, the patient complaining only that "things do not feel right in the joint." A diagnosis of a damaged fibrocartilage should be made in such cases only after very careful examination and consideration. The roentgenogram is of practically no aid, as in the great majority of instances the fibrocartilaginous body of the misplaced cartilage casts no shadow. Occasionally in persons with a history of lockings extending over many years the irritation inflicted on a pedunculated end of the internal semilunar will so harden it that a faint shadow will show in the roentgenogram between the internal condyle of the femur and the tuberosity of the tibia. In such cases, however, the history is usually so clear that the roentgenogram is not a necessary aid in the diagnosis. Nevertheless, any patient with mechanical derangement of the knee should have the benefit of the roentgenographic examination, for it is impossible to differentiate in many cases between a misplaced or loose internal semilunar or external semilunar cartilage and a loose body. The roentgenogram, therefore, may be considered as of the greatest aid in making a differential diagnosis.

It must be constantly borne in mind that while the most frequent cause of mechanical derangement of the knee joint is an injured internal meniscus, other causes also may produce the derangement. In some instances a diagnosis is extremely difficult before operation, and even after the joint is opened the cause is not evident. Surgeons of great experience have acknowledged that occasionally after making a careful search for the condition causing the symptoms complained of,

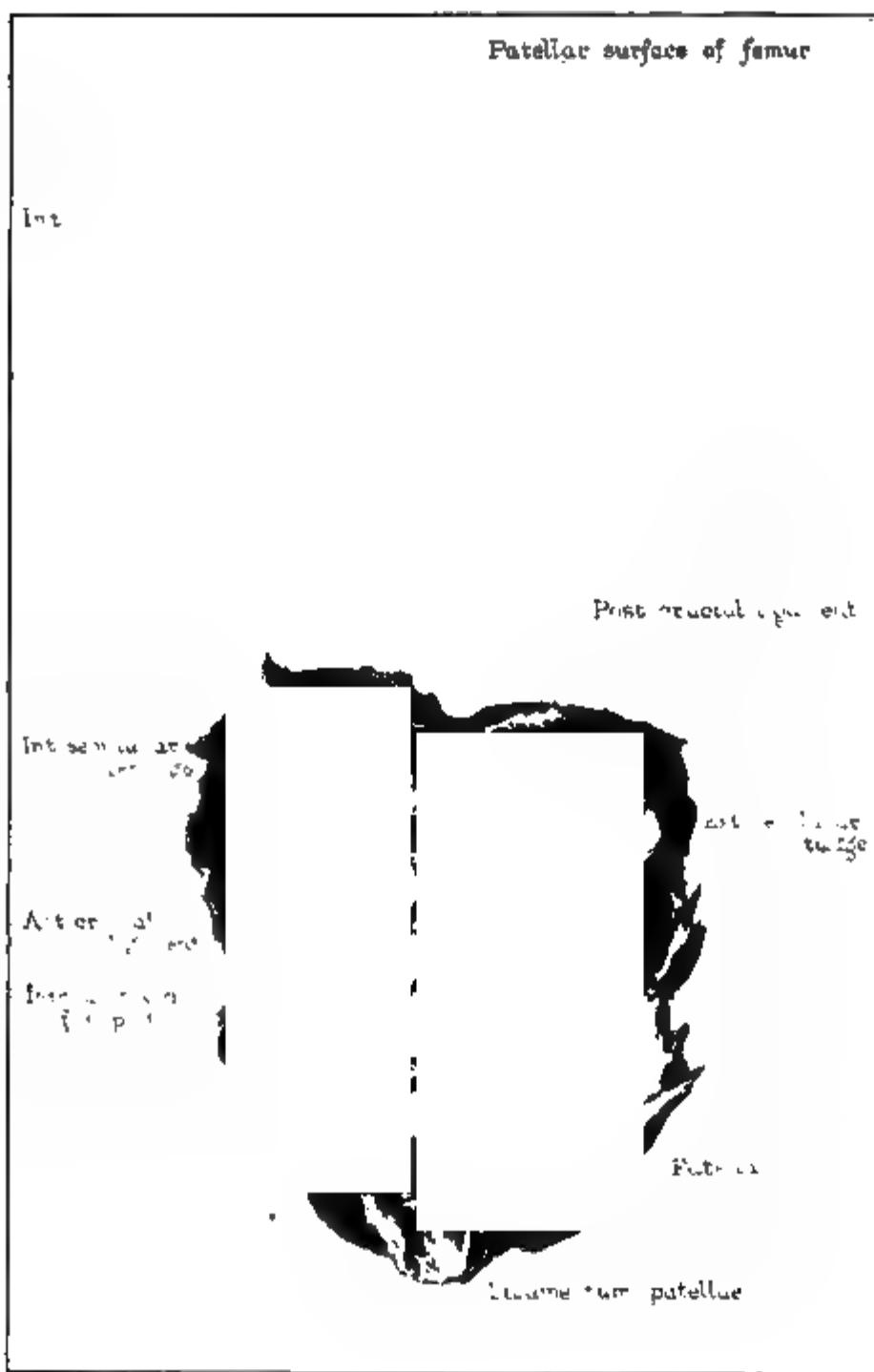


Fig. 1.—Intrinsic structures of the knee joint.

Fig. 2 (116019).—Anteroposterior view showing loose body at site of origin in internal condyle of the left femur.

Fig. 3 (147988).—Cross section of loose bodies, showing cartilage grown around the bone,  $\times 2\frac{1}{2}$

they have closed the knee joint without repairing or removing anything. The removal of the internal semilunar cartilage must be decided from the findings.

According to Lane,<sup>6</sup> periodic derangements of the knee joint may so lower the vitality of the joint tissues that tuberculosis develops. In his opinion the majority of cases of tuberculosis of the knee joint have this as their predisposing factor, particularly in persons who have intestinal stasis. In this contention he is supported by Jones,<sup>4</sup> who adds that rheumatoid arthritis also may be so induced. I have seen a few cases of tuberculosis of the knee in which there was a history of mechanical derangements for some years preceding the onset of the tuberculous arthritis. Such a history, however, was the exception rather than the rule.

The treatment of derangement due to the internal semilunar cartilage is either nonoperative or operative. It may be taken as a rule that patients should not be operated on who give a history of only one locking. If seen immediately after the accident, reduction should be made at once. Complete extension, and the statement of the patient that the joint feels right, is evidence that reduction of the displaced cartilage has been effected. If the patient insists that the reduction is not accomplished, it is probable that he is correct. After successful reduction, rest in bed should be insisted on until the effusion has subsided. Flexion of the knee and strain on the internal lateral ligament should be prevented for six weeks. If the damaged cartilage is given the opportunity to unite firmly in its normal position, the chances for a cure are very good. If the primary care has been careless and the fixation period inadequate, the patient very often presents himself with a story of multiple lockings. In these old cases, operative interference is necessary, for rest and immobilization at this late time will not insure the fixation of the loose cartilage in its normal position. When operation is

necessary for removal of the internal meniscus, the incision of choice is the condylar incision of Jones. It is not necessary to remove the entire cartilage; the anterior three fifths is usually sufficient. Damage to the internal lateral ligament may be avoided by limiting the incision and by leaving a thin rim of the fibrocartilage attached to the internal lateral wall of the joint. This can be done easily by using a tenotomy knife to separate the cartilage, thus avoiding the deep fibers of the internal lateral ligament.

In my series of cases there has been none in which we have found it necessary to remove the external semilunar cartilage. Jones<sup>4</sup> found it necessary to remove it in twenty-four cases, or 7 per cent., of his total. He explains the rarity of damage to this cartilage on the ground that, unlike the internal semilunar which is securely fastened by its ligaments and cannot slide out of the way of harm, the external is more loosely attached and thus escapes injury. However, it should be borne in mind when making a diagnosis that the external cartilage is not immune to damage.

#### LOOSE CHONDRAL AND OSTEOCHONDRAL BODIES

Relatively speaking, loose bodies of cartilaginous or osteocartilaginous consistency are common. They may be either free or pedunculated. Very often when the body is cast off from one of the articular surfaces a piece of spongy bone comes with it. As the body wanders about the joint it receives nourishment sufficient to permit the growth of cartilage until it is entirely covered. Then only by section of the body can the bone be demonstrated (Fig. 2).

The etiology of loose bodies is interesting. It is generally conceded that a certain definite group have osteo-arthritis or Charcot's disease of the joint as their primary cause. This group, however, does not directly concern the surgical aspect of the subject, for in such cases the disease is more important than the mechanical difficulties, which are only incidental. The majority of loose bodies in the knee joint cannot be

explained on these grounds, and it is this majority that are of the greatest interest. Whitelocke<sup>8</sup> believes that many of them have their origin in the fibrous tags that hang from the synovial membrane. He states that as the synovial membrane, articular cartilages and inter-articular cartilages are developed from the same primitive embryonic intermediate layer of the axial blastema, these fibrous tags may readily develop into loose bodies of chondral nature. Koenig,<sup>9</sup> on the other hand, described osteochondritis dissecans as being the cause of loose bodies. Ridlon<sup>10</sup> and Freiberg<sup>11</sup> have more recently called our attention to this condition and reported cases. Briefly, it is supposed that the pathology causing osteochondritis dissecans is a blocking of one of the nutrient end-arteries supplying the joint surfaces, with a consequent desiccation of the localized devitalized area as a free or pedunculated body. Undoubtedly there are such cases. However, it is very difficult to estimate the amount of trauma that may be inflicted on a joint surface by the crushing force exerted on attempted extension of the knee by a curled or crumpled up semilunar cartilage. Owing to its fibrocartilaginous structure, the semilunar cartilage may itself escape any serious damage and yet severely injure the cartilaginous articular surface. In the majority of instances no history is to be elicited of a tendency to form loose bodies, but there is a history of direct injury to the internal condyle of the femur by falling on the flexed knee. The injured area may be chipped off at the time, but more often the area of trauma is devitalized and later separates off and becomes a free body. In the greater number of our cases of loose bodies in the knee joint we were

8. Whitelocke, R. H. A.: Loose Bodies in the Knee, with Special Reference to their Etiology and Growth, *Brit. Jour. Surg.*, 1913-1914, i, 650.

9. Koenig, F.: Ueber freie Körper in den Gelenken, *Deutsch. Ztschr. f. Chir.*, 1888, xxvii, 90.

10. Ridlon, John: Osteochondritis Dissecans, *THE JOURNAL A. M. A.*, Nov. 15, 1913, p. 1777.

11. Freiberg, A. H., and Wooley, P. G.: Osteochondritis Dissecans; Concerning Its Nature and Relation to Formation of Joint Mice, *Am. Jour. Orthop. Surg.*, 1910, viii, 477.

able to demonstrate either by the Roentgen ray or operation that the bodies originated from the thick ridge of the cartilage placed on the internal condyle of the femur to compensate for the wear caused by the normal action of the joint (Fig. 3).

The symptoms are catching or locking of the joint accompanied by pain and followed by swelling. Repeated attacks generally tend to decrease the severity of all the symptoms. Very often the patient is able to locate the body and thus establish the diagnosis. The Roentgen ray in practically all instances discloses the presence of the body, as the cartilage is usually dense enough to cast a shadow, and in many instances a small flake of bone is attached to the cartilage which further aids in the localization. The continued presence of these bodies in a joint causes continued irritation and is apt to produce arthritis. They should be removed, therefore, but before operation care should be taken to locate them as accurately as possible. After the preparation of the knee has been completed, it may be possible to localize the body in the suprapatellar pouch or at either side of the ligamentum patellae. By holding the body between the fingers and infiltrating the skin with local anesthesia, a sharp needle may be pushed through the skin into the body to hold it securely. A small incision down the course of the needle then allows ready removal of the body. More often, however, the body cannot be grasped in this manner and in such cases general anesthesia and an incision allowing the best approach to the body is necessary. If the body rests in the anterior compartment of the joint and on the inner side, the incision on the inner side of the patella permits the easiest entrance. When a more general exploration is necessary, the splitting of the patella as described by Corner<sup>12</sup> allows free inspection of the suprapatellar pouch and the anterior and interarticular areas of the joint. If the

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12. Corner, E. M.: The Surgery of the Knee Joint, THE JOURNAL A. M. A., Sept. 26, 1914, p. 1069.

body is posterior, the incision described by Brackett and Osgood<sup>13</sup> through the popliteal space is the most convenient. The mere presence of a loose body in the posterior part of the joint does not demand its removal. Moreover, it should be remembered that occasionally there are sesamoid bones in the hamstrings that are extremely difficult to differentiate. A sesamoid bone may have a concave surface that fits the convex posterior surface of the condyle of the femur, whereas the loose body, because of its wandering, does not have the shape of its location impressed on it, and is often rounded or oblong. Stereoscopic roentgenograms may show whether the body casting the shadow is resting directly on the condylar surface or is located in the intercondylar notch. If in the intercondylar notch, it is presumably a loose body, but if resting on the condyle it probably is a sesamoid.

#### FOREIGN BODIES

Foreign bodies cause derangements but differ from the previous groups mentioned in that they are of extrinsic origin, being introduced accidentally or intentionally from without. In the literature, needles are mentioned frequently as a finding. In some instances the patient is not aware of the introduction of the needle. Malingeringers occasionally introduce many needles in the knee joint, and the clinical picture is baffling until a roentgenogram is taken. Bullets may enter the joint and be remarkably well tolerated. The presence of a foreign body in practically all instances demands the same operative measures as mentioned for the loose cartilaginous bodies, except that the demand for its removal is even more urgent.

#### SYNOVIAL FRINGES

Synovial fringes or fat tags occasionally cause mechanical derangements, but the symptoms are usually mild. The condition may be due to mild tuber-

13. Brackett, E. G., and Osgood, R. B.: The Popliteal Incision for the Removal of "Joint Mice" in the Posterior Capsule of the Knee Joint, Boston Med. and Surg. Jour., 1911, clxv, 975.

culosis or to some systemic disease, such as syphilis. These facts, together with the mildness of the symptoms, usually contraindicate operative interference. Such tags, as a rule, have their origin on the alar ligament or the fat pad extending on either side of the patellar ligament. Occasionally during the course of an exploration of the joint I have removed a pedunculated flattened fat tag which looked as though it were being habitually squeezed by the articular surfaces. However, that the fat tag may be the sole cause of joint derangement has not in our cases been shown to my satisfaction. Painter and Erving<sup>14</sup> have called attention to the possibility that fat tags may cause symptoms, and have reported cases.

#### THE CRUCIAL LIGAMENTS

The results of rupture of one or both of the crucial ligaments are more serious and disabling than those of what are generally understood as mechanical derangements of the knee joint. Their cause is severe trauma, such as that resulting from the passing of a wagon wheel over the leg. If after an injury with the knee in an extended position the tibia can be pushed forward, the anterior crucial is ruptured. If, with the knee in flexion, the tibia can be pushed backward, the posterior crucial is ruptured. The pain caused by such extensive manipulations usually necessitates an anesthetic. The spines of the tibia may be broken in addition, and occasionally give rise to loose bodies. For ruptured crucial ligaments, Corner has advised operative measures. However, when the knee is properly treated from the onset by placing it at rest in slight flexion in a plaster of Paris cast and maintaining such fixation for three months, a useful knee results. It is tersely stated by Jones and Smith<sup>15</sup> that "modern practice

14. Painter, C. F., and Erving, W. G.: Lipoma Arborescens, Boston Med. and Surg. Jour., 1903, cxlviii, 305.

15. Jones, R., and Smith, S. A.: On Rupture of the Crucial Ligaments of the Knee, and on Fractures of the Spine of the Tibia, Brit. Jour. Surg., 1913-1914, i, 70.

pays not enough attention to the fact that a ruptured tendon or ligament must not be subjected to strain during the period of healing." Use of an injured knee should be permitted only after careful examination. According to these authors, in a case of rupture of both crucials, conservative measures of rest for three to six months promise better results than immediate operation. It is astonishing to what extent, particularly in the young, a knee with relaxed ligaments will regain stability if a suitable brace is provided to prevent strain on the stretched ligaments.

#### END-RESULTS

The cases forming the basis of this report number eighty-seven. They were all under observation in the Mayo Clinic during the interval between Jan. 1, 1910, and Jan. 1, 1916. As many of the patients as possible have been seen or communicated with since their operation, to ascertain the end-result of the treatment accorded them. There were sixty-three males and twenty-four females. The youngest was 14 years of age, and the oldest 67. The average age was 32 years.

The internal semilunar cartilage was judged to be the sole offender and removed in fifty-three cases. We were able to trace forty-four of these patients. Thirty were cured, nine were relieved, and five reported themselves as no better. It is probable that a few of the nine reporting themselves as merely relieved may be considered cured, for in some instances their reasons for stating that they were more or less dissatisfied with the operation were indefinite. However, as the opportunity to make the examinations and observations necessary to refute their statements was lacking, they have been classified as merely relieved. The five patients reported as no better were cases in which at operation no definite pathology could be established and the semilunar was removed on insufficient pathologic evidence. In the majority of these cases it would have been better to have at least deferred operation.

Five patients we were unable to trace. The internal semilunar cartilages were removed from eight knees at the same time that loose bodies were removed. In the majority the loose bodies were the prime cause of the trouble. All of these patients reported themselves as completely cured. In twenty-four instances, loose bodies were removed from the knee joint when they were considered to be the chief offenders. Sixteen patients reported themselves as cured; five were not traced, and three were relieved. The latter three cases were those of elderly people who had arthritis associated with the condition. Undoubtedly much of their present complaint is due to that.

Two cases of rupture of the crucial ligaments were treated conservatively by placing the knee slightly flexed in a plaster of Paris cast. Full function was restored.

To sum up, fifty-six of the eighty-seven patients operated on for mechanical derangements of the knee due to intrinsic causes were cured; twelve were relieved; five reported themselves as no better, and fourteen were not traced.

#### CONCLUSIONS

1. Damaged semilunar cartilages should be accorded the careful treatment by rest and fixation that is given an ordinary fracture of one of the long bones. Recurrent locking will then be an uncommon sequela.
2. Recurrent locking produced by a loose or fractured semilunar cartilage or loose body demands removal of the meniscus or body under the strictest asepsis. A judicial exploration of the joint should be made at the same time.
3. The condylar incision is the incision of choice for the removal of the semilunar cartilages.
4. For the removal of loose bodies, the split-patella incision is usually beset.
5. A ruptured crucial ligament is better treated conservatively than by operation.

## ABSTRACT OF DISCUSSION

DR. JOHN RIDLON, Chicago: I agree entirely with all that Dr. Henderson said, but I would like to say that in injuries of the knee joint where the semilunar cartilage may have been injured, it is most important to put the leg straight in a plaster cast and keep it there until all symptoms have been absent for a long time. If symptoms return without there having been an accident, it is necessary to go into the joint, unless some reason otherwise is shown. I think that we are going to find a lot more cases of osteochondritis dissecans than heretofore. When I published my paper I reported three cases. Before that Dr. Freiberg's case was the first, and I think the only one in this country; and my three were the next. The cases are not common. Dr. Henderson has been able to show a number, probably because he knew what to look for. We have had an unusual case since the publication of my paper. A young woman presented the typical Roentgen-ray pictures of osteochondritis dissecans in both knees. On opening the right knee we found the cartilage of the inner condyle blistered up, but no loose body. In the left knee we found the cartilage in the same condition and a loose body, biscuit-shaped,  $1\frac{1}{8}$  inch in circumference and  $\frac{1}{4}$  inch thick. This was removed. A year later the Roentgen-ray pictures showed a loose body in the right knee, another spot of osteochondritis dissecans in the left knee and another loose body in that joint.

DR. J. P. LORD, Omaha: About twelve or fifteen years ago Dr. Wm. J. Mayo called attention to the advantages of a transverse incision of the knee for extreme infections of the knee joint. Having had experience in opening the knee thus freely with very desirable results, and regarding it as not of serious consequence, I used this method of exposure in one case with highly gratifying results in which the patellar tendon was divided and the knee joint widely opened, which enabled me, with great facility to remove the foreign bodies. They were very large and eight in number, one being nearly two inches in extent, and of a mulberry type. Part of these bodies were well behind the condyles, and it had seemed to me that no other incision would have been adequate to have made an assured success of their removal without, perhaps, more exposure and damage than there was in the very radical procedure of opening the joint in the manner described. I do not pretend to say that this is very often indicated.

DR. W. C. CAMPBELL, Memphis, Tenn.: Dr. Henderson stated that he has not removed a single external cartilage during all the series. A few days before I left I removed the external cartilage from a man who gave a very interesting history. He had three days previously a sudden locking of the knee, which had caught at a greater angle than I had ever seen. It was fixed and held at a right angle. Six or eight

years before, he had had a number of attacks; and then, without treatment, they had stopped, and he has had no trouble for three years. He had always before been able to straighten the knee after a few hours. This time, however, he was unable to do so. He was brought to me with the knee flexed at about a right angle and fixed in that position; I insisted on taking him to the hospital and doing an operation to get the leg down, if he could not reduce it otherwise. He refused treatment or operation, so he went home and stayed there ten days. Then he came back with no improvement in his condition. There was practically no effusion in the joint when the joint was opened. The knee was freely movable in flexion beyond the point of locking. On operation, I found that the external cartilage was so long that it was folded on itself in the joint. I removed it by the usual external incision.

DR. ROBERT B. OSGOOD, Boston: I agree in the main with Dr. Henderson, but I think that it is a mistake to consider this semilunar cartilage problem a simple one or to be dogmatic about the operation. I understood him to say that we should take three fifths of the cartilage away. I am not sure that that dictum is wise, because I have seen certain cases in which perhaps three fifths have been removed, and in which the symptoms of slipping did not return; but the symptoms of riding up over the end of the cartilage left did occur, and seemed to be overcome by an operation which secondarily removed the posterior portion of the cartilage. More than that, cartilages are often found, in my experience, not simply detached in their anterior portion, but sometimes quite extensively detached along their whole border. The flopping inward and outward gives rise to the symptoms. It would be, in such cases, obviously unwise to remove simply the anterior portion. They are sometimes split longitudinally as if cut with a knife from one end to the other. I have found this a number of times, the internal, or joint, side being free, and the other side attached to the coronary ligament. It would obviously be unwise to remove simply the anterior two thirds in such a case as that. These are problems which demand an exposure of the whole site and the condylar incision, which Dr. Henderson advises is the best. I take him to mean an incision that is longitudinal in its upper portion and then sweeps backward at the level of the joint line. At the Massachusetts General Hospital clinic during the last year we have had two cases of external cartilage, as well as internal.

DR. EDWIN W. RYERSON, Chicago: Dr. Osgood's point about the removal of the whole cartilage is excellent. If you are going to remove any, why not take out the whole thing? The operation is easier with the leg flexed at a right angle on the edge of the table. Then the leg can be rotated around, so as to reach the posterior end of the cartilage. The anterior end can always be removed easily. The other end can be

snipped off with a pair of strong curved scissors. Loose bodies are sometimes extremely annoying. If you get into the joint without having first transfixed the loose body, you sometimes cannot find it even with a wide opening. It is possible to take it out under local anesthesia in most cases. In one case in which I was operating under a local anesthetic I could not find the loose body, which was as large as the end of the thumb. The man said, "I can find it for you"; so we put a pair of sterile rubber gloves on his hands, and in a minute he squeezed out the loose body, which flew on to the floor. Another point about the transverse incision is useful. Do not make too long an internal incision. I saw an incision seven inches long made by a surgeon in Chicago. It is only necessary to make a short incision, the perpendicular part being an inch and a half long, and the transverse part about two inches, as described by Robert Jones. I want to report another case of external semilunar cartilage fracture caused by a man being struck by the lower step of a train. It made a great deal of trouble for the patient until the cartilage was removed.

DR. J. T. WATKINS, San Francisco: I understood Dr. Henderson to say that he would not operate when the rupture of a semilunar cartilage occurred the first time. I think it would be right to qualify that statement according to the occupation of the individual. For instance, twice during the last year, once in a painter and once in a carpenter, I had to attack the semilunar immediately. I felt that I could not send the man up on a scaffolding with the knee in that condition, because a recurrence might mean his death by a fall. Mr. Jones, in his classical monograph, warns us that we may find all the symptoms at the inner or the outer side of the point only to find at operation that the other was the one involved. I had that experience last winter. I went in and found that the semilunar on the side where the patient gave all the classical symptoms was as good as any one's, and then discovered that the cartilage of the other side was the torn one.

DR. MELVIN S. HENDERSON, Rochester, Minn.: Dr. Lord mentioned the transverse incision. I have not used it except in resections of the joints, but see no reason why with proper care, avoiding the lateral ligaments, it should not be used in cases such as Dr. Lord speaks of. Dr. Campbell has mentioned the damage to the external semilunar cartilage. To me this is very interesting because in our series we have not such a case. It may be that we have overlooked the condition in some of our cases. Dr. Osgood's criticism is a just one—in the part of the paper I have read I have not mentioned much about the internal semilunar cartilage as I found it necessary to reduce the paper in order to read it in the allotted time. Some of the points mentioned by Dr. Osgood have been taken up in the fore-part of the paper. I believe

that the removal of the anterior three fifths of the semilunar cartilage in the majority of cases is sufficient. Of course, if the fracture is further back it must be removed back of the fracture. One reason for advocating this is that a larger incision is necessary to remove the entire cartilage, and in using the larger incision one is apt to damage the internal lateral ligaments and it is best to avoid this as much as possible. Dr. Watkins mentioned not operating the first time the derangement occurred. If the reduction cannot be accomplished otherwise, of course, operation is necessary. Such a case was that mentioned by Dr. Campbell where he was unable to reduce the dislocation and found it necessary to remove the external semilunar cartilage in order to straighten the leg.

## AN ANALYSIS OF FIFTY CASES OF SCIATICA

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The purpose of analyzing a series of cases of sciatica and presenting it before this section is to discuss whether there is such a condition or clinical entity that is called essential or idiopathic sciatica. Also I wish to discuss in relation to teaching, what should be taught, and in what department of the medical school should it be made the subject of teaching. There is no question but that it is firmly fixed in the layman's mind that sciatica is a disease in itself, a distinct entity, and I am sure that the profession at large also is satisfied that it is an entity, although realizing that at times it may be a symptom of a lesion elsewhere. If we appreciate that there is a definite cause in every case and that cause can be demonstrated as a physical fact, then much of the uncertainty will be changed and the treatment will become more rational and exact.

What is the necessity for discussing this subject? That it is an indefinite and undecided condition is very well shown by any textbook on internal medicine or nervous diseases. Either what the orthopedist believes to be true, and I suppose my experience as brought out in these fifty cases will correspond with yours, is entirely wrong, or else the various authorities on which we have to depend are giving a wrong conception of this condition.

Let me quote from one of the authorities as to treatment:

Certain remedies are of service in sciatica. Prolonged baths give excellent results. The patient must remain in his

bath for several hours. Antipyrin may be prescribed in doses of from 15 to 45 grains. Injections of morphin and inunction of an ointment of methyl salicylate may give relief. Blister, the actual cautery, injections of sterilized water, injections of air, and epidural injections by the sacrococcygeal route have their indications. Bleeding leeches and cuppings are useful.

I am familiar with the teaching of two medical schools and as far as I know sciatica is not definitely taught as a part of the curriculum in either one. I received no instruction as a student and supposed that it was a pure nerve lesion. I rather believe that it is not considered of very great importance, and therefore falls between the departments of medicine, neurology and orthopedics. Therefore we had to gather our knowledge from the textbooks and current literature, and enough has been said to show the confusion that exists, and this is the reason for presenting these facts.

It may be argued that this is a rather selected group of cases, because I would be more likely to see cases with joint symptoms. There is a certain element of truth to such a statement, but many of these cases had been definitely treated for sciatica by other men, with the idea that there was an inflammatory lesion of the nerve trunk. I am sure that this series of cases represent what is commonly called sciatica. Fifteen years ago there were reported from the nerve department of the Massachusetts General Hospital of Boston a large number of cases of sciatica, as shown in the annual report. The other day I went over the records of this same department for the last six months and found three cases that were diagnosed sciatica. One of the staff of that department analyzed these three records, and he could find no evidence of an essential sciatica. In other words, they have no record of such a condition in the last six months.

I was interested in discussing this question of essential sciatica with one of the older orthopedic men, and he said that most sciaticas were certainly due to joint

lesion, but he supposed there must be real sciaticas. But the point is that he never has seen one. Several medical men of good standing have informed me that they have never recognized a case of so-called idiopathic sciatica. Now, where certain groups of men recognize sciatica as a distinct disease, a perineuritis of the sciatic nerve, and that is the commonly accepted pathology, and another group are not sure that there is such a condition, it means either that our older teaching and the larger part of what the textbooks teach are wrong, or that I have not seen the type of cases that they describe. I believe such a fact as here presented in regard to the records of the nerve department of the Massachusetts General Hospital show that we are all dealing with the same type of case, but from a different point of view.

As the analysis of this series will show that the lesion is located at the origin of the sciatic nerve, and not along the course of the nerve as is commonly taught, and as it is the contention that the most common cause is a joint lesion with a secondary effect on the nerve which is anatomically in close apposition to the joints which make up the lower part of the spine, it will be necessary first to consider the various points in the physical examination of any case of sciatica which indicate a joint lesion.

To study the physical examination of such a well-known condition as sciatica would seem to be unnecessary, but certain features seem to me to be overemphasized and are always explained on the basis of a nerve lesion. It is quite easy to demonstrate that an acute attack of sciatica has a definite joint basis, but it is more difficult to explain the cases that show a milder degree of pain and that are more chronic in character, because the symptoms referable to a joint are less marked than the resulting nerve pain.

The evidence of a lesion of any joint, whether due to disease or to trauma, is definite and clear cut. They

are pain referred to a joint, tenderness to touch, limitation of motion, deformity resulting from muscular spasm or from a permanent lesion, and changes in the joint as shown by the Roentgen-ray.

It is very common in sciatica to have the pain referred to the lower portion of the spine, starting from that region and extending down the course of the nerve. Often the patient will put one finger directly over the sacro-iliac joint or the lumbosacral joint and locate the pain definitely at the joint.

In the acute cases, those that are due to an acute joint trouble, there may be definite tenderness to touch over one of the articulations, and sometimes this may cause pain down the sciatic nerve. Of course, it is impossible to cause direct pressure on the nerve by pressing on the posterior surface of the joint, so the effect must be through a sensitive joint and thus to the nerve which lies anterior to the joint.

Limitation of motion of a joint does not need any explanation as an indication of a joint lesion, except to explain how it is detected in lesions about the lower portion of the spine. It may be observed while the patient is standing, and then it will be noticed that forward, lateral or backward bending will either be definitely restricted or will cause pain. A more delicate test is to have the patient while lying on the back and with the knee held straight, flex the leg on the abdomen. This is the Kernig test and has always been explained as causing pain because it stretched the sciatic nerve. It seems to me that the true explanation is that there is a direct leverage applied to the sacro-iliac joint, because with the leg held straight, the ham-string muscles running from the ischium to the head of the tibia pull directly on the joint. I have never been able to convince myself that anatomically the nerve is stretched by this procedure, and I believe it to be a fallacy handed down from one book to another. In the severe cases it often is not possible to

raise the leg in this position six inches from the table and this cannot actually stretch the nerve, while it will pull on a sensitive joint. With the patient lying face downward, hyperextension of the thigh, which pulls on the sacro-iliac joint in the opposite direction, will often cause sciatic pain, and this certainly cannot pull on the nerve.

These two tests, this so-called straight leg raising and the hyperextension of the thighs, are the two most delicate tests that affect the motions of the sacro-iliac joint. It has long been recognized that in cases of sciatica Kernig's test is very apt to be positive, but the interpretation has always been referred to the effect on the nerve and very little mention has been made of its action in causing motion of any joint.

One of the chief symptoms of a lesion about a joint is deformity which arises whenever the lesion is of any intensity. In the knee-joint the deformity is flexion and in the hip-joint it is flexion and adduction, as a rule. So that when we see deformity we naturally look for a joint lesion. In sciatica it is very common to notice a change from the normal position of the lower portion of the spine. This listing or deviation from the normal position is due to either muscular spasm or joint spasm, in the acute cases, or to permanent changes in the joint, in the more chronic cases. It is simply what happens in the course of any joint trouble and is commonly seen in the more severe or acute cases. If the listing persists we have what is commonly called sciatic scoliosis, that is, simply a deviation or a deformity of the spine due to some joint lesion.

Much has been written, especially in the German language, about sciatic scoliosis, but it seems to me that it is simply a symptom and not a distinct condition by itself. For the purposes of this paper I shall not go farther into this symptom, but simply draw attention to the fact that it is indicative of joint lesion.

The Roentgen-ray should be used in the examination of many cases of sciatica, the same as would be done in any joint case, to show whether there is any bone lesion that is the cause of the symptoms. Tuberculosis of the fifth lumbar vertebra is often treated for sciatica for months, because we are content to consider the latter as a disease. Hypertrophic arthritis, or osteo-arthritis of the spine, often has sciatic pain as its chief symptom. Also a careful Roentgen-ray study may show why the joints of the lower spine are subject to chronic strains, because we find that the fifth lumbar vertebra is very apt to show certain changes from the normal, such as extra long transverse processes.

It is not the purpose of this paper to deal with any minute point in the etiology, nor to go into detail in regard to any case, but I shall try to show in the analysis of these cases that a joint in the physical examination shows a lesion and the treatment is based on this fact. Also I shall not discuss whether in any individual case there may be a dislocation or subluxation of the sacro-iliac joint, which has lately been under discussion, but shall call those cases in which this diagnosis might be possible acute joint strain, a term which is broad enough to cover the subject. Nor shall I try to differentiate whether the lesion may be of the sacro-iliac joint or of the lower lumbar joints, because a disturbance of any of these may cause sciatic pain.

Of this series of fifty cases of so-called sciatica, forty-nine showed a definite evidence of a lesion of one of the joints of the lower spine, which include the lumbar articulations, the lumbosacral joint and the sacro-iliac joints. Also there is definite evidence that the lesion of the spine has a direct connection with the pain in the sciatic nerve, as is shown by an increase in the pain when there is an attempt at motion of the joint involved. One case out of fifty showed no evidence of a spinal lesion, but presented the characteristic evidence of carcinoma of the prostate. This case is included and helps to emphasize the point that there is

always a definite cause at the origin of the nerve and not a perineuritis along the course of the nerve.

There are seventeen cases out of fifty which I have classified as acute strain of the lower spine. Most of these represent an acute lesion of one of the sacro-iliac joints, the sciatic symptoms sometimes coming on acutely secondarily to a chronic or recurrent strain of this joint. Two of these cases were first examined after having had severe sciatic pain for over a month, when they presented a sacro-iliac joint so sensitive that the slightest pressure caused intense sciatic as well as joint pain. And yet the patients told me that this was the first time that anyone had ever examined the back. This is so because we have been taught to accept the term sciatica as a clinical entity, and that there was no need of examining further.

There were twenty-one cases out of fifty that are classified as chronic strain of the lower portion of the spine. It is more difficult in this group to connect the sciatic pain with the spinal condition, because the history is often misleading and sometimes shows no direct connection. But in every one of these cases there was definite evidence of a joint lesion, as shown by loss of motion and pain on motion, and it was possible to demonstrate an increase of sciatic pain when the affected joint was moved. It is in this group that we see the so-called sciatic scoliosis, which is perfect evidence of a joint lesion. It is not rational to explain the scoliosis as secondary to the sciatica when they are both symptoms of a joint lesion.

The third group is classified as hypertrophic arthritis, the diagnosis being based on the fact that the Roentgen-ray shows definite overgrowth of bone in the region of the lower lumbar spine, which corresponds to the facts as shown on physical examination. In this group there were eight cases out of fifty. It is not necessary to discuss this group, because all the textbooks recognize that definite spinal lesions may cause sciatic pain.

The last group, four out of fifty cases, were proved cases of tuberculosis of the lower spine in adults. It is of interest to note that two of these four patients were treated for a year for idiopathic sciatica, and the diagnosis was mistaken because someone was satisfied with the accepted theories. It would have been easy to detect a joint lesion as soon as the sciatic pain commenced in these cases, even if it were not possible to diagnose the character of the bone lesion, because there must have been evidences of joint trouble previous to the involvement of the nerve.

It is not the presumption that the only cause of sciatic pain is a joint lesion, but on the basis of these cases it is evident that the joint lesion is very frequently overlooked and its importance not recognized. Of course, it is perfectly irrational to treat the resulting pain, which is advocated in numerous textbooks and current literature, when the trouble lies in the spine. Nobody would think of treating the sciatic pain after he recognizes a tuberculosis of the spine, and therefore the sciatica should not be treated as such when there is definite evidence of a joint strain, which can certainly cause sciatic pain.

The conclusions from this study are two:

First, there is no clinical entity which is commonly called idiopathic sciatica. The evidence is very strong that the accepted theory of a perineuritis due to some inflammatory condition of the nerve sheath is not proved, and that there is always a definite cause at the origin of the nerve. The most common cause of sciatic pain is a definite joint lesion.

Second, if we have to use the term sciatica, and we undoubtedly will, then it should be a part of the orthopedic teaching. One of the chief reasons why there is so much confusion is because it is not well taught, and our knowledge is gathered chiefly from textbooks. It should be in the orthopedic textbooks.

## ABSTRACT OF DISCUSSION

DR. LEONARD W. ELY, San Francisco: I teach my students that there is no such disease entity as sciatica. Sciatica means pain in the sciatic nerve, a symptom, not a disease. Then they go to other departments, and find that it is treated as a clinical entity, by means of electricity, massage and drugs. In almost every case, however, a cause for the pain can be found. When we cannot find a cause, we acknowledge our ignorance, and do not attempt to hide it by calling a symptom a disease. It is high time that sciatica and intercostal neuralgia followed "belly-ache" and "acute bilious attacks," as diagnoses into the scrap heap.

DR. MELVIN S. HENDERSON, Rochester, Minn.: I heartily agree with what Dr. Rogers said, and partly with what Dr. Ely said. I believe, however, that there is a definite group of cases in which you cannot find any cause for so-called sciatica. What are you going to do with these cases? I try to locate the cause, but sometimes cannot do it, and should like to know whether anyone else can do so always. Occasionally I have found that the injection of saline solution cured a small percentage. I try it in that particular group just mentioned, after I have tried out all other methods. The occasional cure secured seems to me to justify the procedure as it is devoid of danger if carried out according to the method of Patrick.

DR. JOEL E. GOLDTHWAITE, Boston: It might be a matter of interest from the point of view of history, to know that at the Massachusetts General Hospital, a number of years ago, these cases were sent to the Orthopedic Department, not at the request of the orthopedic surgeon, but at that of the neurologist, who said that eight out of ten of these cases belonged to the Orthopedic Department, and it was not worth while for them to be sent to the Neurologic Department first, only to be referred elsewhere. He thought it better for the Orthopedic Department to have to send two cases to the Neurologic than for the Neurologic Department to have to refer eight to the orthopedic. That was the attitude of the neurologist years ago. These requests came from the neurologists themselves; and I am under the impression that a smaller proportion of the total number of these cases would now be claimed by the neurologists than at that time.

DR. ROLAND MEISENBACH, Buffalo: I must agree with Dr. Rogers. I was very glad to hear him speak of sciatica as a symptom. I am willing to acknowledge that there is such a condition as sciatica, but I wish to emphasize that it is rare, that when we have sciatica in any way present, it is usually present as a symptom, due to some other cause than sciatic nerve inflammation. One of the best illustrations of this is the sciatica in cases of hypertrophic arthritis, in which the lumen through which the sacral nerves pass gradually

became smaller due to the hypertrophic pressure. Loose pelvic joints are frequently the cause. Sacro-lumbar, or even lumbro-lumbar joints may have a direct bearing on the symptoms of sciatica. We must not forget our anatomy and the relation of the lumbar plexus to the sciatic nerve and to the spine. I do not believe that the injection of saline into the sciatic nerve would permanently relieve cases in which the sciatica may be the chief symptom, but in which there are other conditions, as a loose sacro-iliac or a disturbed sacro-lumbar joint present. However, the injection of novocain may temporarily relieve the patient, but the symptoms will recur. Whenever we meet a case of sciatica, it is our duty to search for the cause, and not treat the symptom.

DR. JOHN RIDLON, Chicago: I have had the pleasure of having to be a month in bed for this kind of pain at least ten times. I have not had Pott's disease, or osteo-arthritis of the lumbar spine, or a slipped sacroiliac joint; so the pain was not due to any of these. I think that this shifting of the name of sciatica to a strained sacroiliac joint is not by any means clearing up the question of painful backs.

DR. JOHN PRENTISS LORD, Omaha: I agree with the majority here that mechanical causes are back of a large proportion of these cases, but I have found that we must consider the patients as individuals the same as we consider those who have pains elsewhere. Some of these pains are toxic. The mechanical condition is not the only one present. The patients are frequently anemic. Some do not eliminate properly. In one notable case in Omaha, the patient had tried all methods of cure; liquid paraffin relieved his intestinal stasis, and as soon as elimination was properly established, his pain disappeared. I think that we must not forget that we are not merely manipulators, but are still doctors. We must recognize the fact that some patients need treatment besides the particular treatment that comes under our specialty. I believe that in some cases in which the pain is inexplicable and you cannot find a cause for it, if you treat the patient in a sensible way recovery may be expected.

DR. FREDERICK C. TEST, Chicago: I differ with Dr. Rogers only in regard to the percentages of the causes that he stated for this pain. In my experience, which comprises approximately fifty cases of distinct pain referred to the lumbo-sacral region, I have not been satisfied that I have had many loose sacral joints. I found that I had to look for the cause higher up, and have almost always discovered an elongated transverse process of the fifth lumbar vertebra. Sometimes this is present on only one side, but very frequently on both, perhaps associated with tilting of the lower spine and generally with stiffness, with pain usually shooting down one sciatic nerve or the other. In such cases, I occasionally find that there will be relief obtained by manipulation, either inten-

tional or, as in two or three cases, the result of some movement on the part of the patient that seemed to free the transverse process and so relieve the pressure—temporarily, at any rate; and sometimes permanently—on the nerve roots. I remember a case in which there was pain in the lower back and extending down the right leg, and in which the roentgenogram showed a decidedly elongated transverse process, on each side of the fifth lumbar vertebra. Operation was declined for the time being; and afterward, while lifting a pail of water from the floor, the patient felt a twist on the right side of the back, and the pain immediately left the right sciatic nerve, and temporarily went to the left. It has since gone from the left sciatic nerve, and she is now free from pain. Regarding the other causes, that cannot be traced to a bony lesion, I personally feel that there is something, at any rate, in the matter of a toxemic neuritis from a focus of infection somewhere in the body. I remember one case in which I was particularly interested in which pain in the sciatic nerve came on three days after a nose operation. After the nose condition cleared up, the sciatica gradually disappeared, but has a tendency to return whenever there is a coryza.

DR. J. D. GRIFFITH, Kansas City: I have under treatment now two cases in which there is a marked sciatica recurring every now and then. I think that there are other causes for sciatica, in addition to the one that Dr. Rogers pointed out, in a number of cases. My cases belong distinctly to the type of enteroptosis. There was an enormously dilated and enlarged sigmoid; and the paresthesia, etc., followed whenever it was loaded. I have found relief by instituting hyperextension, prone hanging and the corset.

DR. EDWIN W. RYERSON, Chicago: I have seen a number of cases of the various kinds detailed here, with the exception of Dr. Ridlon's. One case was rather interesting. An intelligent, strong young man claimed that he had had pain in the back of his calf eight months previously, which did not seem to have anything to do with any traumatism. This pain had gradually worked up the back of his leg, and finally got into the sciatic region. I put on him Dr. Goldthwaite's girdle, but it did not help him. Then I proposed to make a Taylor brace with a pelvic apparatus, but I thought I would first send him to a neurologist. He went to the late Dr. D'Orsay Hecht, who gave him a bad prognosis, saying that the condition was an organic neuritis and would probably result in permanent damage. He advised him to go take mud baths. The man's employer sent him to an osteopath. The osteopath got on his back and twisted him; he felt a sharp pain, but the sciatica disappeared and has never returned.

DR. FRANK E. PECKHAM, Providence, R. I.: I think Dr. Rogers' idea was to trace the sciatica to the sacroiliac joint.

Of course the joint is affected by trouble in still other regions; and you may get a toxic case, as described by Dr. Lord, with a real subluxation, as Dr. Ryerson probably has just described. I had two such cases, one was reduced under ether, presumably a subluxation; and the patient was well afterward and remained so. The other case was one of pain in the groin, which I have seen in quite a few cases. One manipulation without ether, practically cured him; but these are unusual cases. As Dr. Lord says, we must study the patient. Although he has local symptoms, his trouble may be quite general. Another patient was after many trials cured by arch supports. There was a static strain, which is a condition we must consider. There are times when the ligaments require toning up and stimulating, which I do by various physico therapeutic measures. I know of one case in a doctor who had recurrent attacks. By doing gymnastics morning and night, and hyperextending himself in bed, he has been clear of an attack for some time. I think that Dr. Rogers is correct in tracing the pain to the sacroiliac joint, but this joint itself is affected by various infections, and we should look for, and treat these.

DR. JAMES T. WATKINS, San Francisco: Dr. Lord said that occasionally sciatica is of toxic origin. In confirmation of this contention, I should like to report a case I saw. The gentleman, an athletic person, had had recurrent attacks of sciatica for a long time. For four years he had been going the rounds of the physicians. In his youth he had had gonorrhœa and was now obsessed with the idea that this was the cause of his trouble, despite the fact that the best genito-urinary men had found nothing wrong. I pointed out to him that nothing could be gained by duplicating the work which had been done by the exceedingly competent men who had preceded me in his case. We therefore undertook a new departure and had his mouth roentgenographed. My dentist friends advise me that there is no such thing as a healthy adult mouth. This man had pyorrhea and alveolar abscesses. I sent him to Dr. T. Sidney Smith. Dr. Smith advised certain work and that one tooth be extracted. This displeased the patient, so he consulted a dentist who had been recommended to him at his club. This man failed to relieve him. He ultimately returned to me and I sent him back to Dr. Smith. Then he had the tooth extracted. Prior to this he had attacks of sciatica every two or three weeks. Since removing the tooth and having his mouth treated efficiently an interval of some months has elapsed during which he has had no sciatica at all.

DR. ALBERT H. FREIBERG, Cincinnati: We must remember that a man has two sciatic nerves, and also many other nerves. Therefore, there is to be explained why a man happens to have a pain in one sciatic nerve. However much there may be a constitutional cause, either in the shape of

infection or some constitutional disease, such as diabetes, it is only reasonable to suppose that there is a localizing factor to be found, if we only know where to look for it. Since we have been able, by modern methods and investigations, to study better the conditions of the spine, and the pelvic joints, and since we know the relationships of sacrolumbar cord and sacrolumbar plexuses, we have eliminated a large percentage of the unexplained cases. We are called on in every case to tell why the individual has the pain in his right or left sacroiliac region or his right or left sciatic nerve. I do not mean to say that I am always able to tell, any more than any one else. I can give the case a careful analysis by means of the Roentgen ray and other diagnostic helps; but I think that even in those cases in which we are unable to find the localizing factor, we must, nevertheless, assume that there is one that we should probably find with increase of knowledge. We must strive to explain, in every case that comes to us, why the individual has a pain in the sciatic nerve, and not somewhere else.

DR. REGINALD H. SAYRE, New York: We have been over almost all parts of the body, looking for the cause of pain in the sciatic nerve, but no one has mentioned the necessity of looking for fissures in the rectum, for carcinomas, for retroverted uteri, for prolapsed ovaries and dilated colons. Anything resting on the sciatic nerve and hurting it or the sacral plexus may cause this pain.

DR. ARTHUR LAWRENCE FISHER, San Francisco: I should like to emphasize a point in regard to the mechanism of the pain. We are taught that it is due to pressure. Unquestionably, in some cases, it is due to pressure on the nerve; but in others, there is a reflex from the joint, just as the pain in hip-joint disease is referred to the knee. The nerve which enervates the joint comes from the same segments of the cord, as the nerve along which the pain is referred which in this instance is in the sciatic nerve.

DR. MARK HOMER ROGERS, Boston: The chief point to which I wish to call attention is that the lesion is somewhere near the origin of the nerve, and not along the course of the nerve, as is commonly taught. I did not intend to lay stress on the importance of any one joint, namely the sacro-iliac. It is not any one joint, but any part of the lower spine from which the nerve arises, that is the primary cause. If you will examine the spine you will find a spinal lesion in a majority of cases. The strongest point that I have made is the fact that the neurologic department of the Massachusetts General Hospital has no record of a true case of sciatica in the last six months, whereas formerly they had many hundreds.

## FAT EMBOLISM IN BONE SURGERY INCIDENCE AND PREVENTION

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EDWIN W. RYERSON, M.D.  
CHICAGO

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Fat embolism, as a clinical entity, received but little attention in this country until the excellent and scholarly paper of A. S. Warthin<sup>1</sup> appeared in 1913.

The clinical picture in fat embolism is fairly well marked. There is usually an incubation period of from twenty-four to thirty-six hours after the traumatism, whether surgical or accidental. In severe, crushing injuries this period may be reduced to three hours, as in the case reported by Beitzke.<sup>2</sup> Then ensues difficulty in respiration; not a true dyspnea, but rather an air hunger. This marks the entrance of the fat into the lungs from the right heart. Some patients may show no other symptoms and may make a speedy recovery. The temperature is not much elevated in this variety, but the pulse and respiration are rapid.

In severer cases the fat passes from the lungs to the left heart and into the general circulation. Entrance of the fat into the cerebral circulation causes nausea and vomiting, and the patient may become somnolent or comatose. The temperature is much elevated, and may reach 106 or 107 F. Fat appears in the urine and sometimes in the sputum. Petechiae may appear in the skin. It is hardly possible to estimate the mortality rate on account of the insufficiency of records.

The occurrence of several fatal cases in the writer's experience has led him to consider it a much more frequent and serious danger in bone and joint surgery than he had formerly supposed.

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1. Warthin, A. S.: International Clinics, 1913, Series 23, Vol. 4.  
2. Beitzke: Rev. méd. de la Suisse romande, 1912, xxxii, 501; abstr.,  
THE JOURNAL A. M. A., Oct. 19, 1912, p. 1494.

In 1905 a young woman was brought to the Chicago Polyclinic Hospital with a Pott's fracture of the ankle, incurred a week previously, with marked deformity. She was given nitrous oxid gas, and the deformity was reduced without difficulty by the late Dr. A. B. Hosmer, assisted by the writer. In twenty-four hours there was marked difficulty in respiration, and the temperature rose to 102 degrees. No diagnosis was made beyond a probable ether pneumonia. She died in the course of the next twenty-four hours, and necropsy showed marked fatty embolism of the lungs. No examination of the brain was permitted. The urine was not examined for fat.

In 1914 a child was operated on by the writer for drop-foot due to infantile paralysis, at the Home for Destitute Crippled Children. A silk ligament suspension of the foot was done, small holes being drilled in the first and fifth metatarsal bones and in the tibia, through which the silk was passed. In about twenty-four hours the child, who had shown no shock and but little discomfort up to this time, began to vomit and to have difficult respiration. The temperature rose to 103. The urine contained no acetone and no albumin. Fat embolism was not suspected, and no necropsy was obtained.

In the same year a boy of 8 was operated on at the Children's Memorial Hospital for severe paralytic scoliosis. An Albee bone transplantation was made, a splint cut from the tibia by a motor saw being sewed into a cleft made by splitting the spinous processes of the lower dorsal and upper lumbar vertebrae. There was very little shock or postoperative discomfort, but in thirty hours a well-marked air hunger and rise of temperature supervened. The boy died a day or two later. Fat embolism was not suspected in this case, and no special examination was made with reference to it.

The occurrence of these two fatalities naturally caused a great deal of sorrow and anxiety to the writer. The operations had been performed under the same technic which had been used in a large number of other cases in which no such results had been noted. Dr. Ludwig Hektoen, professor of pathology in Rush Medical College, on hearing a more detailed description of the cases than has been given above, said at once that fat embolism seemed to him highly probable. A search of the literature made this probability seem even more certain and also revealed the fact that the large majority of the reported cases occurred after injuries or operations involving the lower extremity.

During the year 1915 another case of fat embolism occurred in the writer's service at the Children's Hospital, in which the diagnosis was made before death and confirmed by postmortem examination. This was an infant about 8 months of age, with congenital club feet. The feet were manipulated under ether anesthesia, and the plantar fascia and Achilles tendon were divided with a tenotome. The day after operation the child began to breathe with difficulty, the temperature rose high, and death ensued a day later. At necropsy the lungs were found to be the seat of marked fatty embolism. No examination of the head was permitted.

Several other cases have been recalled which were probably fat embolism, but which were not fatal, and in which no diagnosis was made at the time.

The treatment of fat embolism, as proposed in the literature, is apparently not on a well-defined basis. Only four specific procedures have received attention.

Czerny<sup>3</sup> advised the injection of 2 per cent. sodium carbonate, probably with the idea of forming a soluble soap. This method has received little support.

Schanz<sup>4</sup> gives a large quantity of normal saline infusion subcutaneously, and would inject it into a vein if the symptoms were very severe. This method does not seem rational to me.

Wilms<sup>5</sup> drained the thoracic duct for four days, with recovery of the patient. This procedure has been recommended by others, notably Tanton<sup>6</sup> in his comprehensive paper. It is based on the theory that the fat is carried principally by the lymphatic system rather than by the venous system, a theory which will find very few supporters.

Riener<sup>7</sup> advised the insertion of a cannula into the saphenous vein, and thence into the femoral vein,

3. Czerny: Quoted by Warthin, Footnote 1.

4. Schanz: Zentralbl. f. Chir., Jan. 1, 1910, abstr., THE JOURNAL A. M. A., Feb. 12, 1910, p. 576.

5. Wilms: Sem. méd., 1910, xxx.

6. Tanton: Jour. de chir., March, 1914, xii, No. 3; abstr., THE JOURNAL A. M. A., May 9, 1914, p. 1511.

7. Riener: Centralbl. f. Chir., 1907.

allowing the outflow of the venous blood with its admixture of fat. This treatment is based on the theory that the dosage of fat which causes the initial symptoms, sufficient for diagnosis, may not necessarily be fatal, and that the fatal dosage has not progressed as far upward as Poupart's ligament. It seems rational and valuable. Tanton<sup>6</sup> and others would open up the area of injury and remove the accumulated blood and fat, using drainage or tamponage. This also seems advisable. Venesection and lumbar puncture have been recommended.

None of the methods of treatment above mentioned, however, can be considered to have any distinct curative value in cases in which a large quantity of fat has been forced rapidly into the lungs. From a study of the reported cases it can fairly be assumed that the process is usually a very rapid one, and that by the time a diagnosis is made any form of recorded treatment is likely to be of little value.

It becomes necessary, therefore, carefully to consider the methods of prophylaxis.

For many years I have seldom used the tourniquet in my operative work, for reasons which need not here be detailed. It is possible that this fact may explain the greater incidence of fat embolism in my clinics than in those of some other operators. No mention is made in the literature of the routine use of the tourniquet as a means of prophylaxis up to the year 1915.

It seems likely that a complete stasis of the circulation during and a short time after the operative procedures would probably prevent or at least reduce the transportation of the fat through the venous channels. Bürger believes that fat already disintegrated may become bound by coagulating blood.

The tourniquet can be left in place for as long as half an hour, and can then be gradually loosened. This idea was suggested in 1914 to Dr. H. Gideon

Wells, director of the Sprague Memorial Institute, and a series of experiments was carried out under his direction at the University of Chicago in the spring and summer of 1915. A large number of dogs and rabbits were subjected to bone operations of various kinds. The writer had supposed that the removal of a bone splint from the tibia would be likely to cause severe fat embolism, since the medulla of the tibia is invaded and more or less injured by the saw blade. The experiments proved that this is not true, and that fractures and contusions of the bones cause much more embolism than does the performance of a typical Albee bone transplant to the spine. The use of the chisel and mallet is far more dangerous than the motor saw.

The experiments showed, also, that when a tourniquet was applied the fatty embolism from all kinds of traumatism to the bones was markedly decreased. This evidence convinced me that the tourniquet should be made a matter of routine in bone surgery.

When the laboratory work had been practically completed (a year after it had been suggested by me), an article was published by L. Bürger.<sup>8</sup> He states that the tourniquet should be applied to ward off fat embolism in all cases of fracture, and advises Momburg's constriction at the waist line in very severe cases, especially with crushing injuries of the pelvis. "Half an hour should be sufficient," he says. Another precaution is to avoid the transportation of patients with such injuries; "any attempt to move them to a distance is liable to bring on fatal fat embolism."

The article confirms that the tourniquet is the best method of preventing fat embolism.

Credit is due to G. T. Caldwell and H. L. Huber of the University of Chicago for their careful and painstaking experimental work along the lines indicated by Dr. Wells.

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8. Bürger, L.: Fat Embolism in Military Surgery, Med. Klin., Sept. 5, 1915, No. 36; abstr., THE JOURNAL A. M. A., Oct. 23, 1915, p. 1494.

## ORTHOPEDIC SURGERY IN WAR TIME

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We are of the opinion that efficiency as it is generally understood should not be the goal of life. But we are also of the opinion that once a goal is set, it should be attained by the least expenditure of any energy which is worth saving, and we believe that this is what efficiency ought to mean.

In a physical conflict such as war, the goal of both sides is set. To attain it each must conserve the physical energy of its soldiers in order to increase their strength in battle. Each must strive for the complete recovery of its wounded in order that the ranks may be kept as full as possible. Finally, but perhaps most important of all in any long conflict, each must see to it that those large numbers who do not lose their lives, but who by reason of their mutilating wounds lose their fighting power, do not become a burden on the industrial community already depleted and vastly overburdened by the necessity of support of the armies in the field. The few left at home are doing intensive work, and the wounded heroes, if the national strength is to be conserved, must have a still further test of their heroism and be made to contribute their remaining energy to help maintain their still efficient comrades.

Our thesis is to be that orthopedic surgery has a very large part to play in (1) assuring physical efficiency in the ranks; (2) in conserving and restoring the function of the locomotive apparatus of the wounded; (3) in providing the physical possibility and perhaps

reorganizing the means by which the war cripples may become happy, productive, wage earning citizens, instead of boastful, consuming, idle derelicts.

#### ORTHOPEDIC EXAMINATION OF RECRUITS AND SOLDIERS IN TRAINING

*Posture.*—It has not been, we believe, solely because of the better appearance presented by erect, full chested men, that all recruits are compelled to go through "setting up" exercises, and that good carriage is so strongly emphasized. Life insurance figures suggest that the number of inches of chest expansion up to certain limits is in direct ratio to the quality of the risk.

This important part of preventive work, namely, the acquisition and maintenance of a good posture, is surely essentially an orthopedic concern. It is well looked after at present by the trainers of recruits. It is possible if orthopedic help were sought that still more might be accomplished in the direction of simplification and more rapid attainment of the desired end.

*Feet and Shoeing.*—We are perhaps tempted to forget in these days of trench warfare that the feet of the soldiers are of supreme importance. The front must be reached often by forced marches. Railroads may supply men and provisions, but do not fight battles or push on as victory is gained. At the Battle of the Marne, an English surgeon, in charge of a hospital near the front by which the armies surged in haste, told me that in the early days there were constantly large numbers of footsore men in every company, sometimes 25 or 30 per cent. These men were inefficient, if not an actual burden.

Being impressed with the large numbers of nurses who had to be temporarily relieved of duty in the course of their training in a large general hospital on account of foot strain, the writer began many years ago to examine the feet of all probationers as a

routine when the classes entered. Suggestions as to shoeing and any necessary immediate treatment, etc., were made on the basis of this examination, and on the basis of the muscle balance tests, by which potential trouble may be discovered. By this method it was possible to actually eliminate foot strain from the causes of disability among the nurses who followed instructions. In armies the soldiers *must* follow instructions.

We believe that careful tests of this sort would more than compensate for the time consumed by the discovery of potential but correctable faulty weight bearing and the assurance of more constant and continuous efficiency when severe tests came.

The American army shoes, as far as we have been able to ascertain, are vastly better than those of many other nations, and several of the so-called army shapes leave little to be desired. It was most satisfactory to pick out an unusually good shoe from among hosts of bad ones which the patients in a French hospital were wearing, and to find that this was an American shoe and was being supplied to certain of the French soldiers.

No care can be too detailed as to the fit, shape and quality of soldiers' shoes. Battles may be lost or won by shoes alone. In a questionnaire conducted by Dr. Smith Peterson and the writer at the American Ambulance in Paris, many more than half of the 200 soldiers under investigation had suffered from blisters and other more serious foot troubles caused by faulty fitting and faulty fashioned shoes. A man may not fight at his best with a blister on his heel.

#### ORTHOPEDIC SURGERY IN A BASE HOSPITAL

The opportunities for preventive orthopedic surgery have not ceased when the base hospital is reached. They have hardly begun. The wounds of the war are nearly all infected. Healing is delayed, and contractures and adhesions are almost certain to occur, unless

these dangers are appreciated and future function striven for quite as strenuously as the healing of the wound.

Ankylosis, after joint injuries with their accompanying infections, is a very common and unfortunate sequela, but the degree of this misfortune depends on attention to the position in which the joint stiffens, and every joint may be said to have its position of choice. For example, a stiff shoulder in 45 degrees of abduction, an elbow in 90 to 100 degrees of flexion, a knee in 20 to 30 degrees of flexion, are often not serious handicaps, whereas an arm glued to the side, a fully extended elbow, a knee flexed to a right angle, represent actual crippling and require an operation or a forcible manipulation, which, because of the previously septic nature of the wound, may not be without serious risk.

I shall not discuss at length the problems of immobilization of joints and compound fractures of bones. These matters have been considered in some detail in a previous paper; but I would remind you that no surgeon should be as well qualified to deal successfully with these problems as an orthopedic surgeon. Mr. Robert Jones has his great orthopedic base hospital at Alder Hey near Liverpool, Professor Lange his German orthopedic base at Munich. Both these masters make trips to the front and instruct the surgeons in the orthopedic technic of splints and plaster, but unless we are much mistaken, in the other base hospitals of both these countries, and surely in the base hospitals which we observed in France, there is still very great opportunity for orthopedic endeavor, and this endeavor is sure to yield full compensation for labor.

In our own experience we found plaster of Paris most adaptable for immobilizing even the septic compound fractures requiring constant irrigation. Wide reinforcing bridges must, of course, span the open wound, and nice application must be had; but in hands.

familiar with its use it serves its purpose well. The ingenious splints of Mr. Jones, Dr. Joseph Blake and other surgeons are also most useful, and the overhead suspension, or so-called Balkan splint, often used in combination with metal splints, adds greatly to the comfort of the patient and often facilitates drainage.

*Problems of Restoration of Function.*—The return of function in wounded and infected joints depends on many things: first, of course, on the extent of the injury, and second, on the seriousness of the infection. We have been impressed by the power of repair which the ends of bones possess and also by the considerable amount of resistance which the synovial membrane displays.

It seems to us that conservatism should be practiced in regard to early excision of joints, and that multiple incisions and absolutely free drainage should be reserved for those cases which actually *do* need it. We do not believe in making these incisions and providing this drainage in cases which *may* need it. We are aware that occasionally we shall be sorry that we did not thus widely open and drain, but we are sure we shall many more times be glad when we simply wash out the joint thoroughly and leave only a tiny rubber tissue drain running into or down to the joint opening. Joint function returns very quickly and perfectly if the latter procedure is successful, very slowly, or not at all, after the former.

We need not emphasize the importance of massage and early gentle, active and passive motion to prevent the formation of permanent adhesions.

Brisement forcé, which is usually resorted to if these early movements have not been carried out, is a most unsurgical procedure, and only rarely successful.

There are now several very excellent universal mechanotherapeutic machines, both French and German, which, working on the principle of the pendulum, afford excellent opportunity for the slow but safe lim-

bering out of joints and stretching out of muscular contractures. The results which they accomplish are slowly gained, but they may be expected to be permanent and we know no shorter road.

*Operative Orthopedic Surgery.*—As the war progresses there will be no limit to the field of what may properly be called orthopedic operative surgery. There is ample opportunity for its practice now, but with septic compound fractures, in which wide gaps of bone exist, grafts are obviously not advisable until the sepsis has thoroughly disappeared, and in stiff joints all experience teaches that no attempt should be made to perform arthroplastic operations until long after the septic process has been quiescent, how long may be found to vary with different germs. Perhaps a year is not too long as a working rule.

Many limbs are saved now that formerly would have been amputated, both because it is more possible to save them and save life as well, and also because the supply of artificial limbs bids fair to be so inadequate for some time to come. In these limbs, position has often been sacrificed to life, and realinement will be necessary. A further task and opportunity for orthopedic surgery is thus presented. These are only a few of the tasks and opportunities.

#### ORTHOPEDIC WORK WITH CRIPPLES

*Apparatus.*—The cripple has a right to look to the orthopedic surgeon for an amelioration of his condition. Much may be done by preventive and restorative surgery alone; much more may be accomplished by the added use of apparatus of one sort or another, supportive, retentive or corrective.

The little book of Spitz and Hartwich gives us an idea of the care with which these matters are being considered in Germany. Not only adaptations of the standard types familiar to all orthopedic surgeons are required, but also various forms of inexpensive prostheses are in constant demand for both upper and lower

limbs. It would be hard to conceive of a more ample opportunity for exercise of mechanical ingenuity than that presented by the maimed limbs of the returning soldiers. Even if funds were at hand, which they are far from being, there is apparently a completely inadequate supply of the modern expensive and complicated and not always durable forms of artificial limbs. Once given the occupation, an inexpensive and adaptable makeshift can usually be planned and can be easily obtained.

*Occupational Training.*—This brings us to the consideration of the occupational training of cripples. It is fitting that orthopedic surgeons should take the lead in organizing this work, as they have done in the past and are doing now in Europe.

Here in America, although much has been accomplished, most of the cripples throughout the country are cripples still, and idlers instead of special wage earners. There can be no question as to which state of being is of greater use to the nation, or as to which state is the happier state for the individual. We should surely appreciate the importance of devoting much energy in our several communities to a rounding up of these interesting people and providing them, probably by state legislation, with vocational training. This is a form of preparedness of which every pacifist must approve.

We point with much satisfaction to a recent bill introduced into the Massachusetts legislature by Representative John L. Monahan and just signed by Governor McCall, the provisions of which are as follows:

*Resolved,* That the board of education is hereby directed to investigate and report to the next general court, on or before the second Tuesday of January, 1917, what facilities exist in this commonwealth and what provisions have been made to give special training and instruction to persons who have suffered the loss of sight or loss or injury of limb or member and whose earning capacity has been destroyed or impaired by such injury, for the purpose of reestablishing or increasing the ability of such persons to earn a livelihood,

and also to investigate and report what provision has been made or opportunity furnished for such purposes of training or instruction in other states and in foreign countries, and to include in its report a statement of the opinion of said board on the advisability of action on the part of the commonwealth to establish or extend means for such training and instruction, and also to submit drafts of such legislation as they deem necessary to carry into effect their recommendations.

The American Orthopedic Association at its last executive session appointed a special committee, of which Dr. J. E. Goldthwait is chairman, to consider ways and means by which the orthopedic surgeons of the country may organize a national orthopedic reserve. Detailed plans of an orthopedic base hospital are being worked out and sources of supply assured. We urge most strongly the cooperation of this section, both officially and individually, with this committee. It seems to us of great national importance — how great it may be, we trust we shall never know. At the executive session it was recommended that a committee be appointed by the Chair, and Dr. Goldthwait was appointed chairman of this committee also.

We believe orthopedic surgery in times of peace is a most comprehensive specialty; in war time the possibilities of its helpfulness are still greater. The fact that these possibilities are not always recognized should make orthopedic surgeons seek opportunities to demonstrate them. If this opportunity is accepted it may well mark an epoch in the history of the specialty.

372 Marlborough Street.

#### ABSTRACT OF DISCUSSION

DR. NATHANIEL ALLISON, St. Louis: I succeeded Dr. Osgood at the American Ambulance last summer. In the early months of the war in Europe, I speak particularly of the French and Belgian sides, the hospitals were not adequately prepared, and the surgeons comprehended little of what they had to do. Supplies were not forthcoming. General surgeons, medical practitioners—all the leading men in France, were called to the colors, to serve in such ways as they could in inadequately prepared hospitals with no sup-

plies. The American Ambulance was in a fortunate position, having an excellent building, unlimited supplies, and being able to spend on the care of the patient about five francs a day from the donations that were made for the hospitals. This is much more than can ordinarily be afforded in France. Mr. Frederick Villars, a war correspondent who has followed all the wars that have occurred in the last thirty years, said that the American Ambulance was the best military hospital that the world had yet seen.

The thought this brings up to us is what we would do for the care of tremendous numbers of wounded, if war should come suddenly on us. The more or less of a catch word we all are using, "preparedness," is apt to be only a catch word, unless things are taken quite seriously. These men come in in hundreds and thousands, and they must be taken care of, and their wounds are of the most severe character. The American Ambulance, in its first year, treated three thousand patients, with a death rate of 8.8 per cent. This compares very favorably with any municipal hospital. In the first year they did only eighty amputations. That shows what orthopedic surgery—the hospital was practically an orthopedic hospital—has done. No one thought of anything but conserving the limbs to the best function that could be obtained for them. Everyone tried to devise means to conserve them, and in that way, these very original and valuable appliances that Dr. Osgood has shown you have come into use.

Some provision should be made in this country for taking care of tremendous numbers of wounded. I hope that we shall never have need to have such measures put into effect; but if we should, the need will come suddenly and not after months of preparation. The American Orthopedic Association, to this end, appointed at its meeting in Washington, D. C., a committee to standardize some notion of what orthopedic surgery could do in case such a condition should arise with us, and I would suggest that this section might also appoint such a committee.

DR. EBEN W. FISKE, Boston: My experience was, perhaps, a little different from that of Drs. Osgood and Allison. Dr. Osgood said that preventive orthopedics had hardly begun when the base hospital was reached, and this is very true. But on the other hand, orthopedic surgery is as essentially prophylactic as it is reconstructive, and nowhere is this truer than in its application to the surgery of war. How large a proportion of the cases in Europe which are today requiring late treatment for deformities were preventable no one can say. Of course, lack of time and material, and the presence of wide-spread infection, make it very difficult to carry out these measures; yet even with the first dressings certain knowledge of the mechanics of fractures must be employed, and all the way back, long before the base hospital is reached, there are innumerable opportunities for the

application of orthopedic principles toward the prevention of deformity and the preservation of function. Naturally in the most severe injuries we must first preserve the limb, if not the life, with the establishment of full drainage. Second in importance is immobilization, and lastly, alignment and orthopedic principles. In the moderate injuries, however, which furnish the largest proportion of cripples, we can do a great deal. It is as easy, for example, to put up a wrist in dorsiflexion as in any other way, yet it is not always done. Again, among the minor injuries, the necessary rest and relaxation of the exact structure damaged, to be obtained by orthopedic measures, is greatly neglected, although this would often prevent the patients' transfer back to the base, a matter of extreme importance in keeping the maximum number of men in active service. Dr. Osgood advised the use of plaster-of-Paris and I think from his experience he is fully justified. But in many of these early purulent conditions, it has been the experience of many good observers that splints are superior to plaster because, provided the immobilization is perfect, the splint is usually cleaner and gives more chance for drainage and dressing; it allows observation of the limb for spread of infection or gangrene and control of the secondary hemorrhage, and for early massage and manipulation. But the choice of the splint is very important. Traction and coaptation together are undoubtedly the ideal method of putting up fractures of the extremities, but traction with the body weight as a counterforce is not ideal, because every movement of the body creates spasm, so prejudicial to the comfort and safety of the patient. Pull and counterpull within the splint is ideal and is so used throughout the English army, after the Thomas method. It is also adapted to the arm, with the counter-pressure by a padded ring against the chest wall. A material now generally used is an aluminum alloy rod, which can be easily bent, cut or spliced, and can take the place of any splint, even the Thomas. I want to call this splinting to your attention, because I feel that orthopedic surgeons in this country should be familiar with a material that is so universally applicable and valuable in war surgery.

DR. J. D. GRIFFITH, Kansas City, Mo.: I want to second the suggestion Dr. Allison made that we should have a committee appointed from this section, such as was appointed from the American Orthopedic Association, for the purpose of helping us in being prepared for an emergency. To one who has been along the line the absolute unpreparedness of this country is apparent. We ought to be prepared thoroughly.

DR. JOEL E. GOLDTHWAITE, Boston: The committee of the American Orthopedic Association was appointed with the idea of trying to standardize, or decide what is the best equipment for an orthopedic base hospital, or what material should be used in any hospital unit which might be established,

whether a general or special orthopedic unit. It was also thought possible to have the members of the Orthopedic Association and all the men in the country who are interested in orthopedics get together, so as to be made available for service in case of need. The committee consists of Drs. Allison, Henderson, Forbes, Erving and myself. Already General Gorgas has been written to, and the plan put before him, and he is most cordial in his wish to have the thing go on. It is a part of the committee's expectation after they have worked out what is necessary for an equipment of a unit, to have such collections of material stored in different parts of the country ready for use, these storage places to be known to the National Academy, and also to the army. All of us must feel that the great need is for our doing something that will put us in a position very different from what most of the nations abroad were in when the war begun. Then too, it is not only in the time of war that opportunities of this kind are available. When the war is over there will be an opportunity to get orthopedic experience, for hospitals are being established to help those who have been crippled. It is the hope of the committee that any of the men here wishing to join an orthopedic unit will communicate with the committee. The committee will send letters to all those doing work in our specialty; but in case they should not hear on account of error in the mails we should like them to send a statement of their age, experience, whether married or not, etc., to the committee. We can have the names classified so that the government will have men fitted for different kinds of service. Some could go to the front, others could go to the base units. It will help the committee if you will do this.

END RESULTS OF THE TREATMENT OF  
TUBERCULOSIS OF THE SPINE, HIP,  
KNEE AND ANKLE JOINTS

FROM THE RECORDS OF THE NEW YORK ORTHOPEDIC  
DISPENSARY AND HOSPITAL

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During the past twenty years treatment of joint tuberculosis at the New York Orthopedic Dispensary and Hospital has been for the most part conservative, the main object being to procure as near as possible immobilization of the diseased joints.

Weight bearing has been considered advantageous when it did not interfere with fixation, as in the knee and ankle joints, but of considerable disadvantage when it did interfere with fixation, as in the hip and spine.

Ankle joint disease has been treated by fixation with stiff ankle brace having a molded foot piece which fits inside the shoe, plaster having been used as temporary dressing only. The use of crutches has been necessary at times when the disease has been too acute to permit of weight-bearing.

In the treatment of knee joint disease a stiff leg support has been used ; this is fastened to the shoe and extends to the groin, with a leather backing extending from the thigh band to the calf band, thus forming a trough in which the leg is firmly held by a muslin bandage, extending from the middle of the calf to the

top of the brace. The bandage is changed daily, thus assuring constant fixation, and ready accessibility to inspection by the surgeon. The only exception to this rule has been in those cases with marked flexion deformity. This has been reduced with a plaster cast supplemented by traction, the cast being changed weekly.

The management of hip joint disease brings other factors into consideration. Owing to the conformation of this joint, it is difficult under any circumstances to eliminate all motion. This is at once rendered impossible when weight-bearing is allowed. The Taylor hip splint has been used almost exclusively for this condition, since it eliminates weight-bearing by its crutch action. While the traction on the thigh supplied by this apparatus does not separate the joint surfaces, as was formerly supposed, it does render valuable aid to joint immobilization.

Up to the year of 1910 the Taylor spinal assistant was used entirely in the treatment of Pott's disease. It is easy to apply, can be accurately adjusted, is not liable to cause excoriation, is sanitary and renders the spine constantly accessible for inspection by the surgeon. In spite of the careful treatment given each patient, it has been impossible to prevent increase of deformity in a large percentage of cases. This is especially true when the disease involves the dorsal region, because owing to the movement of the thorax during respiration, no form of apparatus yet devised is capable of accurately fixing this area. It is true that in some cases of cervical and lumbar disease deformity can be prevented by mechanical apparatus.

Because of the inability accurately to fix the spine, and thus prevent deformity, it occurred to Dr. Hibbs that it might be possible by operative procedure to produce a fusion over the posterior aspect of the diseased and adjacent vertebrae, thus eliminating motion, limiting deformity, and giving nature a better opportunity of combating the disease.

With this end in view, the first osteoplastic operation on the spine was performed Jan. 9, 1911. The results obtained in those patients operated on in the early part of 1911 were so gratifying that for the past four years operation has been advised as a routine in all cases except those in which complication rendered the prognosis hopeless. This treatment has been supplemented by a spinal assistant worn from six to eighteen months after operation. Operative treatment is particularly advantageous in early cases, as it offers a means of limiting deformity and shortening duration of treatment.

The accompanying tables report only those cases of joint tuberculosis in which the patients were under 16 years of age at the time treatment was begun, who came to the dispensary between the years of 1895 and 1910, and whose treatment was continued two or more years.

TABLE 1.—ANKLE JOINT DISEASE

Total number of cases of ankle joint disease treated.....	50
Number of boys treated.....	28
Number of girls treated.....	22
Number of cases with right ankle involved.....	31
Number of cases with left ankle involved.....	19
Average age on admission, years.....	5½
Duration of disease on admission, months.....	7½
Average duration of treatment, years.....	4½
Number patients cured.....	23
Number under treatment at present time.....	0
Number died.....	6
Number could not be located.....	21
Of the patients cured, number with free motion with no deformity of foot .....	15
Number with limited motion with no deformity of foot.....	6
Number with limited motion and deformity of foot.....	2

TABLE 2.—KNEE JOINT DISEASE

Total number of cases of knee joint disease treated.....	156
Number of boys treated.....	87
Number of girls treated.....	69
Number of cases with right knee involved.....	83
Number of cases with left knee involved.....	73
Average age on admission, years.....	6½
Average duration of disease on admission, years.....	2
Average duration of treatment, years.....	7
Number patients cured.....	106
Number under treatment at present time.....	7
Number died.....	7
Number could not be located.....	43
Of the cases cured, number with lengthening of limb.....	10
Number with no change in length of limb.....	73
Number with less than 1 inch shortening.....	7
Number with less than 2 inches shortening.....	14
Number with more than 2 inches shortening.....	2
Number with flexion deformity without ankylosis.....	5
Number with flexion deformity with ankylosis.....	13
Number with ankylosis without deformity.....	13
Number with fifteen to ninety degrees flexion from full extension .....	36
Number with more than 90 degrees flexion from full extension .....	39

TABLE 3.—HIP JOINT DISEASE

Total number of cases of hip Joint disease treated.....	461
Number of boys treated.....	236
Number of girls treated.....	225
Number of cases with right hip involved.....	242
Number of cases with left hip involved.....	219
Average duration of disease on admission, years.....	2
Average age on admission, years.....	7
Average duration of treatment, years.....	7½
Number patients cured.....	171
Number under treatment at present time.....	44
Number died.....	60
Number could not be located.....	215
Of cases cured, number with less than 1 inch shortening.....	40
Number with less than 2 inches shortening.....	59
Number with less than 3 inches shortening.....	60
Number with more than 3 inches shortening.....	21
Number with adduction and flexion deformity combined.....	36
Number with flexion without adduction deformity.....	17
Number with bony ankylosis.....	13
Number with fibrous ankylosis.....	49
Number with no destruction of femoral head (Roentgen examination) .....	32
Number with partial destruction of femoral head (Roentgen examination) .....	86
Number with complete destruction of femoral head (Roentgen examination) .....	88
Number with partial acetabular destruction but no evidence of disease of femoral head (Roentgen examination).....	6
Number with dislocation (Roentgen examination) .....	3
Number with thigh flexion from 15 to 90 degrees.....	73
Number with more than 90 degrees thigh flexion.....	45
Number with perfect function without deformity.....	35
Number with relaxation of knee joint.....	20

TABLE 4.—POTT'S DISEASE

Total number of cases of Pott's Disease treated.....	517
Number of boys treated.....	284
Number of girls treated.....	233
Location of disease: Cervical.....	47
Upper dorsal .....	71
Middorsal .....	118
Lower dorsal .....	105
Dorsal-lumbar .....	100
Lumbar .....	76
Average age on admission, years.....	5½
Average duration of disease on admission, years.....	1½
Average duration of treatment, years.....	7½
Number patients cured.....	125
Number under treatment at present time.....	7
Number died.....	112
Number could not be located.....	227
Of the cases cured, number with marked increase in deformity..	50
Number with slight increase in deformity.....	42
Number with no increase in deformity.....	28
Number with no deformity.....	5
Number of cases operated on.....	48
Number of cases not operated on.....	77
Number of cases in which deformity increased, following operation	10
Number of cases in which deformity did not increase after operation .....	38

## CONCLUSIONS

From the foregoing statistics it would seem that the following conclusions are justified:

1. The regions most frequently involved in joint tuberculosis in order of frequency are the spine, hip joint, knee joint and ankle joint;

2. The disease is more frequent in boys than in girls;
3. The disease affects the joints of the right side more frequently than those of the left.
4. The average duration of treatment of all joint disease patients was six and one-half years.
5. Joint tuberculosis is usually well advanced before diagnosis is made, the average duration of the disease on admission being one and one-half years.
6. The average age of patients when admitted for treatment was six and one-fourth years.
7. Ankle joint disease can be cured in most instances with little or no deformity.
8. Of the knee joint cases seen, 15 per cent. had more than 1 inch shortening; 25 per cent. had ankylosis; 75 per cent. had more than 15 degrees motion from full extension; 38 per cent. had more than 90 degrees motion from full extension.
9. Of the hip joint cases cured, 34 per cent. had less than 1 inch shortening; 24 per cent. had varying degrees of flexion and adduction deformity; 28 per cent. had bony or fibrous ankylosis; 55 per cent. had none or only partial destruction of the heads of the femora; 55 per cent. had more than 15 degrees flexion from full extension; 9 per cent. had some degrees of relaxation of knee joint.
10. In Pott's disease the dorsal region is much more frequently involved than all the other regions combined; 73 per cent. of all cases of Pott's disease had perceptible increase of deformity during the course of treatment.

Of the patients operated on, 20 per cent. had some increase in deformity following the operation, but in no case was there actual increase in deformity of the area operated on.

## ABSTRACT OF DISCUSSION

DR. JOHN RIDLON, Chicago: The results of this work are remarkably good. Of the twenty-three cases of ankle joint disease cured, fifteen had free motion, with no deformity of the foot. It has been a belief of mine for many years that ankle-joint disease is the most favorable kind of chronic tuberculous joint disease we have to handle. I have seen a tuberculous ankle joint go through several years of disease, have abscesses and sinuses developed, and go on to spontaneous opening and healing, without having been treated or having been seen by a doctor during the course of the disease, recovery taking place without deformity and with almost a normal range of motion. This may be the explanation why so remarkably large and good results followed in the cases of the disease reported in the paper. In the knee-joint disease, there were eleven in which there was actual lengthening of the limb. I have seen this in only one or two, or two or three cases, perhaps; and it is my conviction that these are the cases in which the knee-joint disease is a syphilitic inherited disease and in which the disease is located, not within the joint itself, but at the epiphyseal line of the femur, as was the case in such instances of lengthening as I have seen. There were five that had flexion deformity without ankylosis, and thirteen that had flexion deformity with ankylosis at the knee joint. I believe that if we can control our cases, we ought to be able to cure all without flexion deformity. Of the hip-joint cases one hundred and seventy-one were cured. Only thirty-six had adduction and flexion deformity and seventeen had flexion deformity without adduction deformity, making a total of fifty-three treated by the long traction hip-splint of Taylor. I have used that splint all my life, and have never been able to get anything like such good results from it. I am amazed that such a large proportion can be cured without adduction deformity. It shows the careful attention that the patients have had, and is a wonderful result. Eighty-eight had complete destruction of the femoral head, and only a partial acetabular destruction. My experience, when I have had the advantage of Roentgen-ray examination, is that I have found a larger number showing destruction of the acetabulum than of the head; and unless these have all been carefully checked up and the sockets compared with the sockets on the other side by Roentgen-ray examination, I should doubt that result. Of the one hundred and seventy-one cases, here are one hundred and fifty-three cured without motion. There are beautiful results, and it shows how absurd is the position of Lorenz that cases should be treated to secure ankylosis as soon as possible, and that it is impossible to cure these cases with motion. We know that it is possible to get a large number of cases cured with motion, and here are the results. Twenty were found, after cure, with relaxation of the knee-joint. That has been one of

the unpleasant results that I have had from the use of the long traction splint, and I have ceased to use it as soon as I find the knee joint begins to be lax. I have used it, in the past longer and in more cases than necessary, and I believe that we should have obtained as good motion and less deformity, with no relaxation of the knee joint, if we had discontinued its use and put the patients in some form of immobilizing apparatus, allowing them to walk on these limbs.

DR. REGINALD H. SAYRE, New York: The institution is to be congratulated on the results shown in the paper, but the statistics do not give very much information. Here are sixty-three patients getting well of hip disease with flexion and adduction deformity, but there is nothing to show how much of that was due to faulty care in the institution, and how much to inattention on the part of the parents and their lack of taking care of the children as they should. There is nothing in the statistics to show how much deformity the patients had when they came under observation, as compared with what they had when they went out from under observation. This is true of the statistics of most of our institutions. I feel somewhat as Dr. Ridlon does regarding the difficulty of preventing flexion deformity in the hip by means of the hip splint with simply a pelvic belt. For years I have been using a thorax belt, as well; and since I have adopted this, the patients have not had flexion deformity, if there was regularity in the attendance of the patient. I think that Dr. Phelps was right in his contention that we should make the splints as nearly fool-proof as possible in dispensaries, and also in private practice. In regard to the relaxed knees, I believe that they are caused by our own inattention, and that we often pull on the shin instead of on the thigh. Frequently, when the patients' legs itch, they pull the plaster off the thigh; and we pull on the shin, instead of the thigh, without noticing it. Berkley Hill of London, Eng., some forty years ago, drew my father's attention to the possibility of doing that, and getting relaxed knees in the treatment of hip diseases by the Sayre splint. My father said, "You get relaxation of the knee-joint from it; because you pull on the shin, instead of on the thigh." That is the trouble in many of the relaxed knee-joint cases. This report distinctly shows that ankylosis is not the thing to be desired in joint disease. I believe that the nearer you get to a normal joint, the more desirable the result will be. That is not the German idea, and I know that some of my American friends think that you should strive for ankylosis of these joints. I know, however, that I can frequently obtain movable joints; and as long as I can do so, I will follow the efforts to get them.

DR. CHARLES M. JACOBS, Chicago: I should like to have Dr. Humphries tell us whether he uses only long traction hip splints on all his hip cases; and if not, what are his results with the use of the plaster casts.

DR. ROBERT E. HUMPHRIES, New York: Dr. Ridlon says that he has found a greater percentage of cases with acetabular destruction, than this report indicates. The cases considered in this report as having had acetabular destruction showed no evidence of disease in the head of the femur on Roentgen-ray examination. Many cases showed destruction of both the head of the femur and the acetabulum and are therefore only considered under the heading of destruction of the head of the femur. The good results obtained were due mainly to two factors: first, a large out-patient nursing staff which keeps in constant touch with the patient, instructing the parents in the adjustment of braces and in the hygienic care of their children and also seeing that the patients are brought regularly to the dispensary; second, a country hospital where many of the cases reported were treated. Patients with joint tuberculosis cannot be cared for properly at home without frequent visits by nurses and they can be taken care of very much better in a country hospital devoted solely to the treatment of joint tuberculosis. The point advanced by Dr. Sayre, that statistics are always inaccurate because one cannot tell what percentage of poor results are due to inefficiency on the part of the surgeon and that due to the neglect by the parents, is a good one; however, I do not see how this can be ruled out. Plaster of paris is never used except as a temporary dressing, consequently it is impossible at this time to compare this form of treatment with that of plaster.

## THE EVOLUTION OF OSTEOCHONDRITIS DEFORMANS COXAE JUVENILIS

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CINCINNATI

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In 1905 I described<sup>1</sup> two cases of arthritis deformans coxae juvenilis whose chief clinical interest lay in the impossibility, at that time, of distinguishing them from adolescent coxa vara without the aid of the Roentgen plate. They were the first cases of the kind reported in this country, and the examination of the roentgenograms made it evident that we were dealing with deforming disease of the hip which must have been in existence for a long time and with whose early clinical phase we were totally unfamiliar. In both instances we were dealing with intelligent patients coming from excellent social environment, and it would be only fair to presume that we might rely on the accuracy of their statements with reference to the indefinite character of the symptoms which were present in the early stages of the disease. Both patients presented themselves with what was a finished deformity of the joint, to all intents and purposes, and both of them were under observation for over a year without material change in their condition, when the report was made. The title to this report seems to have been misleading, since I have been made to call these cases adolescent coxa vara, by some who have quoted them. Although these cases had a history strikingly similar, the roentgenograms have, in the light of present knowledge, very striking differences. These differences have assumed a practical importance to me in view of additional experience. In the first case we

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1. Freiberg, A. H.: Am. Jour. Orthop. Surg., July, 1905.

were dealing with a boy of 14 years, and the Roentgen ray presented a deformity of the head of the femur best described by speaking of it as "mushroomed on the neck." The second case was that of a young man 22 years old, who had been aware of the condition since his sixteenth year; the roentgenogram showed here a deformity of the femoral head, such as is often seen in the so-called arthritis deformans of older persons, and which has been aptly likened to the shape of the glans penis. In both cases there was positive denial of any injury which could be of causative importance.

Since the report of these cases and those which preceded it, much progress has resulted in the study of the deforming hip disease of the young. This is most largely due to the work of Perthes, who in 1910 described the early symptoms and characteristic Roentgen-ray appearances of a disease involving chiefly the upper epiphysis of the femur, and it was he who first brought these changes forward as ending finally in a deformation of the head of the femur and the acetabulum which had been spoken of as arthritis deformans juvenilis. Even though the deformity of the femur in its later stages bears much resemblance to that seen in the so-called arthritis deformans of adults, the disease which produces it in children and the changes seen in the roentgenograms nevertheless differ markedly from the disease of adults spoken of by Goldthwait as "hypertrophic" and by Nichols as "degenerative" arthritis. The most striking difference is seen in the absence of new bone formations, or osteophytes, in those portions of the joint peripheral to its bearing surface. In the symptoms, also, the disease of early life differs from that of the adult, being in the former of much milder character, and, indeed, often of such insidious course as to escape detection until the terminal deformity has been discovered. That these juvenile cases have in their earlier stages and in former years constituted largely the class of

cases which we formerly regarded as mild hip tuberculosis seems today quite evident. It seems very clear now that we have found here the explanation of the remarkably complete restoration of function in cases of hip disease which were sometimes brought forward as evidence of the efficiency of this or that method of treatment or of some one's particular skill in applying it.

The identity of the disease accurately described by Perthes and which begins usually prior to the eighth or ninth year of life with a characteristic flattening of the capital epiphysis of the femur, and that condition seen in adolescence as a mushroom deformity of the upper end of the femur, seems today quite clear. It has been established by the roentgenograms of cases seen early in the disease and those taken years later during the adolescence of the same patients. Still more striking is the observation I have made in the first case which I present.

CASE 1.—The patient is a boy of 12 years, who came because of marked limp with flexion and adduction deformity of the right hip of one year's duration. Although there was little pain, there was distinct tenderness over the femoral head, and after a clinical examination, I thought I was dealing with the deformity of hip tuberculosis. Nothing was said concerning the left hip, and my clinical examination did not disclose any abnormality. The boy was otherwise apparently well, though undernourished and pale, and his temperature was 99 F. and over on several occasions. The roentgenogram was made of both hips (Fig. 1); the right hip showed typical flattening of the capital epiphysis. The epiphysis was quite dense with areas of increased radiability. The left hip, to my surprise, showed marked mushroom deformity of the head; the capital epiphysis was greatly reduced in height and increased in width. The mother, on being questioned, remembered a period of limping about six years before but had ascribed no importance to it. There was no history of trauma more severe than that usually to be found in active children. This case furnishes striking testimony to me, were further evidence required, that we are dealing with two phases of the same lesion, early and late. I do not mean, of course, to infer by this report that it is extremely rare to see this disease in bilateral form. Bibergel, in a bibliographic summary, found ten reports of such cases.

I have, however, found two cases among my records which are still more instructive, to my mind, since they were carefully observed during a number of years. Furthermore, they were recorded at frequent intervals by Roentgen rays from a period near the inception of the disease to the time when the terminal mushroom deformity was presented in characteristic manner. Both cases were looked on originally as tuberculous, and the one which I shall present was roentgenographed regularly at intervals of three months during the whole active period of the disease. I look on it as offering certain important features in connection with the question of etiology and pathologic physiology.

CASE 2.—S. C. W., a boy 7 years of age, was brought to me in January, 1907. He was an unusually well developed boy, very tall and heavy, with the appearance of robust health. The child of well-to-do parents, he was reared in a very favorable rural environment. In August, 1906, he began to limp without having had any injury of consequence, as far as his parents knew. Very soon after this he complained occasionally of pain in the groin and knee, of the right side. Still later there developed starting pains at night without later consciousness of suffering. He was still having distinct night cries when I examined him. At this time he was walking with a decided limp, standing with enough abduction to obliterate the right gluteal fold. There was  $\frac{1}{2}$  inch atrophy of the right thigh, and motion was limited in abduction, adduction and both internal and external rotation. The right hip was held in 7 degrees of flexion. There was tenderness over the femoral head and thickening about the neck. Some elevation of body temperature was always present on the numerous occasions when it was taken. No tuberculin test was made. The roentgenogram (Fig. 2) made at this time shows a typical flattening of the capital epiphysis of the femur, which is itself of greater than normal density, whereas there is some bone atrophy in the upper part of the neck.

At this time the boy was taken to Dr. V. P. Gibney for consultation, who concurred in my diagnosis of tuberculous disease and returned him to me for treatment. This consisted in the application of a traction brace with partial recumbency. Some time later he was brought with a condition of greater sensitiveness, and he was crying out quite often every night. He was therefore kept in hospital for

several weeks in bed with traction, and was then sent home with a plaster spica and stiltng brace. In May, 1908, the examination showed shortening of less than  $\frac{1}{2}$  inch, no night cries, and very little muscle spasm. The general condition was excellent. The roentgenogram made at this time (Fig. 3) shows, however, a marked change in the capital epiphysis; a piece appears to have separated distinctly from its lateral third. There is no sign of disease in the acetabulum. The boy had been treated for some months by means of Marmorek's serum and was one of a series of cases reported by me for this reason. In October, 1909, the examination showed him to be in excellent condition, without pain, tenderness or spasm. There was complete range of motion in the hip except in rotations, where a few degrees of limitation persisted. The roentgenogram (Fig. 4) shows a return of density in the capital epiphysis; the lateral part which seemed to have separated has apparently reunited. The epiphysis, however, is much flattened, and its lateral end is curved over the lateral aspect of the upper part of the neck. The acetabulum seems still unchanged. The boy was now permitted to go without any mechanical protection. He was seen from time to time during the year 1910, and was then dismissed from observation. In January, 1915, eight years after the first examination, he was again brought for examination because of a return of limping. This was not marked, and there was no pain. Limitation of motion was present in extremes of rotation only. The roentgenogram (Fig. 5) made at this time shows the typical mushroom deformity of the head with the flattened epiphysis.

Viewed in the light of present knowledge, it seems plain to me that this case must be regarded as of non-tuberculous character, and that it belongs distinctly in the category of osteochondritis deformans juvenilis as described by Perthes. The symptoms which were present must be looked on, however, as much more severe than we are accustomed to observe in such cases. Even so, to me they now spell an affection of infectious or toxic character, of low grade. Such a case coming today, in its beginnings, would call for a careful search for an infection atrium, and I regard it as more than probable that its discovery in tonsils or elsewhere would result in cutting short the progress of the disease and very likely the further development of deformity.

It seems erroneous to me to hold that a case has been made out for the traumatic origin of this disease. In the cases which I have observed the history of injury has always been most indefinite and not to be brought into clear relationship with subsequent symptoms or even with the side of the body which we find affected. The development of the disease in the opposite hip at a later time without the occurrence of distinctly related trauma would seem also to speak emphatically against injury as a cause. On the other hand, I believe that a search backward into the early history of well observed cases would usually reveal symptoms of distinctly inflammatory nature, such as slight fever, local tenderness and muscle spasm, to say nothing of the distinct night cries which I have noted in the two cases mentioned. The cases of congenital luxation of the hip which have been forcibly manipulated and which are used by Legg in support of the theory of traumatic causation are not convincing to me. In them the trauma is more direct than we are able to determine in our cases of osteochondritis; on the other hand, cases of congenital luxation which have gone unreduced without attempts at replacement very often show a deforming process in the femoral head which is presumably due to the effect of continued abnormal function. I have shown this to be the case, in fact, with traumatic luxation in the adult which has remained unreduced for years.

It seems to me far better to assume, as an etiologic basis for *osteochondritis deformans juvenilis*, a chronic infectious process of probably secondary character, just as we do in explaining other deforming joint diseases of later life. The circulatory peculiarities on which Legg<sup>2</sup> lays stress may be used to explain the changes which take place, even more appropriately in connection with infection and its associated progressive character than with trauma. This accords

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2. Legg: *Surg., Gynec. and Obst.*, xxii, 307.

with the vascular theory of Wollenberg with which I have been concerned in another paper.<sup>3</sup> Therefore, I feel that there is no occasion to change the name given to this disease by Perthes and that it should remain until we can speak in more exact terms of its etiology and pathology. Thus far no cases have been continuously followed by Roentgen-ray observations for a long enough time to determine what the truly terminal deformity really is or to what extent it may change during the later years of adolescence and adult life. On the contrary, it seems likely enough, in conformity with the observations of Preiser and others, that such a degree of disturbance of the joint mechanism will have as its result further deformity and disablement, as the years go on.

If these considerations are to be taken seriously, as based on reasonable premises, it would be fallacious to assume that because the symptoms are of mild character and because recovery with much joint motion may be expected, mechanical protection is unnecessary or unimportant in this disease. There is reason to believe that the terminal deformity is due to weight bearing and motion as much as in tuberculous disease, and the influence of the deformity in producing disablement many years afterward we do not even know. As the result of our errors in mistaking these cases for tuberculosis in past years, we know that long continued fixation of these hips does not interfere with the return of joint motion; for this reason I believe that this form of treatment should be patiently and carefully carried out. If at all to be modified this should perhaps be done to the extent of adding stighting to fixation. Finally, I would urge again that in all future cases it should be incumbent on us to give our patients the most careful scrutiny in the earliest stage possible with a view to ascertaining the existence

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3. Compare Freiberg and Woolley: Am. Jour. Orthop. Surg., 1916, viii, 491.

**Fig. 1 (Case 1).—Roentgenogram of hips.**

**Fig. 2 (Case 2).—Roentgenogram taken January, 1907.**

**Fig. 3 (Case 2).—Roentgenogram taken May, 1908.**

Fig. 4 (Case 2).—Roentgenogram taken October, 1909

**Fig. 5 (Case 2).—Roentgenogram taken January, 1915.**



of focal infection, such as in the tonsils. If discovered early and given appropriate treatment, this would bid fair to save for our patients future disablement and deformity and to abbreviate greatly the course of the disease.

19 West Seventh Street.

#### ABSTRACT OF DISCUSSION

DR. JOS. R. KUTH, Duluth, Minn.: Dr. Freiberg, in drawing attention to infection as an etiologic factor in this most interesting condition, touches on what is most important as related to treatment. Up to the present time, most attention has been given to the deformity itself, to late results in the hip joint, and to the amelioration of deformity by treatment. In the few cases that I have seen and have been able to study, the destruction of the head at the time of first examination (and this was the first time that these patients presented themselves for treatment) was so far advanced that one could hope for very little more than a further increase in the shrinking-up process of the splintered head. Among these cases was one which ran remarkably parallel to the one that Dr. Freiberg described as being probably a severer form of Perthes' disease.

In these cases I was left with the same impression as regards the infective origin as was Dr. Freiberg. The history of any injury was either denied or was so vague as to be valueless as a causative factor. It would seem that if we are to derive much benefit from treatment of the condition from the infective point of view, either in the eradication of a local focus or in the treatment of some distant focus, this should be done much earlier than the time we generally see these cases. Inasmuch as these cases come for treatment at a time when the disease is far advanced and the deformity established to the extent in which we generally see it, the disease can probably be correctly described as a self-limiting one, the best treatment being rest, fixation and weight removal. I did not understand Dr. Freiberg as saying that all cases of osteo-arthritis deformans of adolescence are due to a pre-existing Perthes' disease. It would seem, from the cases described by Maydl, Zesas, Frangenheim, Von Brunn and others, that there really are cases of what is known as osteo-arthritis deformans coxae of adolescence in which the individual may not have had a previous Perthes' disease. If we are to think that these were probably cases of Perthes' disease, the observations of the Germans regarding the previous history, the date of onset, and the pathologic findings at operation, would then be very misleading.

DR. FREDERICK C. KIDNER, Detroit: My support of Dr. Freiberg's theory of the infectious origin of the cases of

so-called Perthes' disease is based on the study of only a single case. It was a typical case of osteochondritis juvenilis, except in two particulars. First, the child, in the beginning, had a slight fever, lasting three or four days. Second, when he went to the hospital, he had eleven thousand white cells with 80 per cent. of polynuclears. The roentgenogram was typical. The depression below the epiphyseal line was very plain, and there was one spot in the neck of the bone which closely resembled an abscess. I tunneled in through the greater trochanter, and opened a cavity just below the epiphyseal line, from which was obtained a low-grade staphylococcus, which died out in the second generation and could not, therefore, be used for guinea-pig inoculation. It seems, on the basis of this case alone, that many of these cases are due to hematogenous infection originating somewhere else, as in the tonsils. I wish, also, to make a plea for a longer and more persistent treatment of cases of Perthes' disease, because I think that many of the so-called "mushroom" hips of adult life originate in this disease.

DR. JOHN RIDLON, Chicago: I have a case which, from the roentgenographic findings, I believed to be a typical case of Perthes' disease, but which went on to the development of a typical tuberculous abscess. I am not yet certain that in Perthes' disease we really have a separate entity that can be diagnosticated with certainty.

DR. VIRGIL P. GIBNEY, New York: While Dr. Freiberg was describing the case in which he overlooked the other hip, I was reminded of two cases in young boys that I have seen within the last few years whose hips seemed to be going to pieces. Some men said they were tuberculous. I protested that they were not. An internist got hold of a rather stout boy, and treated the intestinal tract. The stools were examined, carefully and repeatedly, and bacteria far in excess were found, easily accounting for the infection. In a recent paper, Dr. Niles reported the boy's health restored, with restoration of function in both hips. I begin to feel as Dr. Freiberg does, that we are all at sea on our tuberculous hips; and I seem to feel hesitation in calling a case one of tuberculous disease without resort to laboratory tests. We may think it is that, because of the symptoms; but we make no test; or, if we do, we say that this test is not always reliable, and we feel that we are not getting very far. With the aid of the intestinal specialist, the proctologist, the laryngologist and the dental surgeon, however, we may be able to find out the cause of infection. Many are said to be rabid on the subject of special tooth abscesses. We do not find them in children, but we find other foci of infection in the teeth of children. A laboratory for the study of dental diseases will be established in Columbia University within a short time. We should rely more on the pathologic findings in connection with accurate Roentgen-ray findings.

**DR. HENRY LING TAYLOR**, New York: A year ago I reported nineteen cases of Perthes' disease. The cases now number over thirty. There are several things quite evident from this and other material, and one is that the cases are not tuberculous. Another is that the statistics of tuberculous hip disease have been seriously vitiated by counting these cases among them; just as formerly they were vitiated by counting in cases of coxa vara. The latter condition has been separated from tuberculosis of the hip, and these cases will also have to be separated from it. I pointed out, a year ago, that Perthes' disease was the foundation of some cases of osteo-arthritis in adults; several such cases have been observed. These cases have practically all been diagnosed as tuberculosis of the hip; and even when the patients have recovered entirely from the disease, the fact that such a diagnosis has been made is a handicap to them. It was pointed out by one of them, a doctor, that he had to pay a higher premium for life insurance on account of his hip condition having been diagnosed as tuberculous, which it was not. In my series of thirty odd cases, several were ushered in with symptoms suggestive of infection. Several others followed trauma; but both of these classes together constitute but a small minority of the whole number. The treatment needed is very much milder than that for tuberculosis. I have seen one case that seemed absolutely to demonstrate the evil effect of routine treatment on orthopedic lines. The case was that of a young boy whose symptoms began over four years ago. The condition was diagnosed as tuberculosis of the hip joint and the child was treated with the long traction splint. The affection was certainly Perthes' disease, and the child now has over an inch and a quarter of shortening, of which one inch may safely be ascribed to the long continued suspension of the limb. I feel, therefore, that it is an error to overtreat these cases.

**DR. ALBERT H. FREIBERG**: With regard to the cases reported by earlier observers as cases of arthritis deformans of traumatic origin, I went over these reports very carefully. In the cases of von Brunn, particularly, osteophytes are described; but a careful examination of his illustrations fails to show that what he calls osteophytes should be so considered, in the light of what we now know about these, in deforming disease of the hip joint. They are irregularities of bone, but not new bone-formations, which we mean by the word osteophyte. At the same time, the reproductions are by no means excellent in the works referred to; and it is possible that if I had the original negative or the original prints, I might come to the opposite conclusion. The histories are not characteristic. There is no convincing evidence that any severe injuries happened to the children. That a child had a fall and later developed symptoms, is just the kind of history we hear today in regard to tuberculosis of the joints, and does not prove an etiologic relation. We must be careful about the effects of our treatment in these cases. We are prone to feel that if, after

a year or so, there is an apparent return to normal function, and there has been no loss of motion or length, the case is to be considered as finished; but the examination of the one case which I have reported shows that we are in no position to say what the end results will be in eight or ten years, so we shall have to be careful in coming to the conclusion that a case is ready to be released from treatment. How an excess of protection can result in loss of length in a limb, is difficult to understand, except when the treatment happens to deprive the limb of function. In the same way, in many cases of infantile paralysis the shortening is due to lack of use. I should like to see such cases submitted to weight-bearing to some extent, rather than to the amount of protection that we have been using for tuberculous disease.

# HEREDITARY DEFORMING CHONDRO-DYSPLASIA—MULTIPLE CARTILAGINOUS EXOSTOSES

A REVIEW OF THE AMERICAN LITERATURE AND REPORT  
OF TWELVE CASES

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In the fall of 1914 a case of multiple cartilaginous exostoses, so-called, appeared during my service at the Children's Hospital. With the permission of Dr. Lovett I investigated the case clinically and roentgenologically, and removed a strip of bone from across an affected epiphysis for pathologic study. The results of this investigation were presented in an article<sup>1</sup> published in May, 1915.

In reviewing the literature, I found that although the disease is generally considered rare, and textbooks in English give little or no place to it, more than 600 cases had been reported from all over the world, and about 350 articles had been written on the subject. The American literature I found to be very scanty.

As a logical sequence to my previous article, I proposed to discover if possible how frequent the condition really was in this country, and what its clinical and roentgenologic manifestations were. Accordingly I present herewith (1) a review of cases hitherto reported in the United States; (2) a report of a series of personal cases; (3) observations as to the character and occurrence of the disease based on these cases, and (4) conclusions.

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1. Ehrenfried, Albert: Multiple Cartilaginous Exostoses—Hereditary Deforming Chondrodysplasia, THE JOURNAL A. M. A., May 15, 1915, p. 1642.

## REPORTED CASES

The first case reported of this country was by Gibney.<sup>2</sup> In 1875 he showed a boy of 13 who presented the typical picture. At 7 years he had been confined in bed for a long while with "acute rheumatism," and at 10 years he had recurring pain in his right hip. Gibney<sup>3</sup> presented this patient again in 1879. At this time he showed several new exostoses, and some of those formerly present seemed to have increased in size.

In 1876 in an article on the subject, Gibney<sup>4</sup> presented a family consisting of a Prussian of 34 who had many large irregular hyperostoses, with subluxation of one finger and left genu valgum. Over some of the hyperostoses the skin was cicatrized, representing ulceration from friction. The growths were said to have reached a maximum size at puberty, since which time many were said to have decreased in size. His father and brother were said to be affected, and his daughter of 11, son of 9, and daughter of 4 were presented as well defined cases. This is the first family reported in this country, and it is interesting because in the first generation there is one person affected, in the second two, and in the third three.

In 1889 Leidy<sup>5</sup> reported a case in an Irish girl of 25 who presented multiple bony tumors, those about the knee being unusually large, causing pain and interference in walking. There is no statement concerning heredity.

Wright,<sup>6</sup> in 1887, showed a boy of 11 presenting the typical picture.

2. Gibney, V. P.: Multiple Exostoses, Med. Rec., New York, 1875, x, 300.

3. Gibney, V. P.: Multiple Exostoses, Med. Rec., New York, 1879, xv, 589.

4. Gibney, V. P. : Hereditary Multiple Exostoses, Am. Jour. Med. Sc., 1876, lxxii, 73.

5. Leidy, Joseph, Jr.: An Unique Case of Multiple Exostoses, Tr. Path. Soc., Philadelphia (1887-1891), 1891, xiv, 5; Univ. Med. Mag., Philadelphia, 1888-1889, i, 230.

6. Wright, J. W.: Multiple Asymmetrical Spongy Exostoses, New York Med. Jour., 1887, xlvi, 358.

Davis,<sup>7</sup> in 1905, reported two cases; one a man of 53, no hereditary history ascertained, presenting typical knockknee, curved and shortened forearms with displacement of the carpi, subluxation of a finger, pes valgus, rosary and enlargement of the spines of the seventh cervical and first and second thoracic vertebrae. He came under observation on account of suppuration of an exostosis of the femur. This case is interesting because during a year, under the observation of Dr. Davis, a small growth on the ramus of the left pubis diminished noticeably in size. The second case was a child of 3, with rosary, knockknee, etc. No family history was obtained.

In the discussion of this paper, Dr. H. L. Taylor reported a family in which the father was probably affected, a boy of 12, a girl of 10, and a boy of 8, definitely so. A. H. Freiburg described a case in a man of 80, who was operated on for popliteal aneurysm caused by friction of an exostosis. In this patient the family history went back three generations. Dr. D. D. Ashley reported a girl of 11 and a boy of 9 affected, with a history of the affection reaching back to include the mother, grandmother and great-grandmother.

In 1907, Ochsner and Rothstein<sup>8</sup> reported an interesting case of intraspinal exostosis. The patient was a man, aged 23, without known hereditary history, in whom the condition was noted at the age of 2; 108 exostoses were counted, including an unusual one on the left superior curved line of the occiput. The patient stated that these exostoses grew at the same rate as he did until the age of 19, when they stopped. At 14 he began to have incoordination of the lower extremities, which condition grew worse so that during the past year the upper extremities were involved and

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7. Davis, G. G.: Multiple Cancellous Exostoses, Am. Jour. Orthop. Surg., 1905-1906, iii, 234.

8. Ochsner, E. H., and Rothstein, T.: Multiple Exostoses, Including an Exostosis Within the Spinal Canal, with Surgical and Neurological Observations, Ann. Surg., 1907, xlvi, 608.

there was pain on the right side of the body on turning the head to the right. Rothstein diagnosed an exostosis within the spinal canal on the right side, and at operation his diagnosis was confirmed and an intradural pediculated tumor, which was flattening the cord, was removed from the anterior aspect of the right lamina of the second cervical vertebra. The operation was unfortunately followed by quadriplegia with loss of bladder and bowel function, from which condition the patient gradually improved, so that he was walking with crutches at the time of the report.

Clark and Atwood,<sup>9</sup> the same year, in a series of interesting neurologic cases, reported one as "a case of multiple enchondroma, one of which is growing from the sella turcica, causing pressure on the pituitary body." The patient was a boy of 17 with spastic quadriplegia, the same one described later by Oberndorf.

Withington,<sup>10</sup> in 1907, showed an Italian, aged about 35, who was suffering from acute articular rheumatism; multiple exostoses were found on examination, and were said to have existed since early childhood. No history of heredity was made.

Oberndorf,<sup>11</sup> in 1910, described in some detail the case already reported by Clark and Atwood. The boy was of German parentage, aged 19 years. No history of heredity was noted, but the father and mother were second cousins. The condition was first noted at 4 years, and the mother said that many growths had appeared and vanished spontaneously. One rapidly growing tumor over the precordium was removed at the age of 11 by McBurney, and the pathologic diagnosis of enchondroma was made. The boy suffered from acute rheumatism at the age of 12. He had a

9. Clark, L. P., and Atwood, C. E.: A report of Cases of Landouzy-Déjérine Myopathy (Congenital), Thomsen's Disease, and Enchondroma of the Hypophysis, New York Med. Jour., 1907, lxxxvi, 97.

10. Withington, C. F.: A Case of Multiple Symmetrical Exostoses, Boston Med. and Surg. Jour., 1907, clvi, 200.

11. Oberndorf, C. P.: A Case of Multiple Exostoses Coupled with Syringomyelia, New York Med. Jour., 1910, xci, 479.

scoliosis with some apparent kyphosis and forty palpable masses. The hands and feet were increased in size and the finger tips were blunt and spadelike, suggesting acromegaly. Oberndorf considered this due to a growth in relation to the sella turcica causing pressure on the pituitary body. For the past three years the patient had suffered from a marked syringomyelia, and some months after his coming under observation died of inanition, complicated by bedsores.

Coon,<sup>12</sup> in 1912, reported the case of a boy of 15 without hereditary history. He presented an atypical picture. The deformities affected particularly the right leg and arm. The left limbs showed mild bony changes on Roentgen examination, but were practically without deformity. In the fingers of both hands, roentgenoscopy revealed chondromatous masses involving the metaphyseal ends of the phalanges; in the right forearm the shortening appeared in the radius, rather than in the ulna, where it usually occurs. The lower end of the radius showed typical broadening and striation of the metaphyseal extremity with distortion of the epiphyseal line. The same was true of the right shoulder, knee and ankle.

Boggs,<sup>13</sup> in 1913, reported the case of a man, aged 23, who was said to have been born with bony tumors, and whose father had bony tumors. Roentgenoscopy revealed the characteristic clinical picture, with a normal sella turcica. The patient had been blind for about a year, and the legs had become weak eight months before he came under observation. There was moderate double optic atrophy. The thyroid gland was not made out. The case was reported as one of multiple congenital osteochondromas with thyroid atrophy, degeneration in the acoustic and optic nerves, and muscular atrophy.

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12. Coon, C. E.: Dyschondroplasia, Am. Jour. Orthop. Surg., May, 1912.

13. Boggs, T. R.: Multiple Congenital Osteochondromata with Degeneration of Cranial Nerves and Muscular Dystrophy, Bull. Johns Hopkins Hosp., 1913, xxiv, 210.

In 1913, Vaughan<sup>14</sup> emphasized the hereditary nature of multiple exostoses.

Carman and Fisher, in 1915,<sup>15</sup> reported the case of a man, aged 23, in whom no heredity was ascertained. It was noticed at birth that the arms were thick at the elbows and wrists. The bony tumors were not particularly noticeable until the age of 8, when they began to grow, and continued to increase parallel to skeletal development until about 22, when growth ceased. He came under observation on account of an irritation abscess over an exostosis on the clavicle. He was 5 feet 9 inches tall, and showed bony growths generally distributed, including the jaw, costochondral junction (rosary), and scapulae. He had scoliosis, relative shortening of the left arm and leg, moderate flatfoot, synostosis and clubbing of fingers and toes, and asymmetry of the toes. An exostosis within the pelvis was felt by rectal examination. The forearms were exceedingly deformed and short, the right showing the typical deformity in moderate degree and the left showing an exceeding degree of hyperostosis at the lower end of the shafts of the radius and ulna, with the hand dislocated inward and the upper end of the radius dislocated outward. The ulna being extremely short, the length of the relatively long radius was taken up by a spiral twist of the radius about the ulna.

Percy, in 1915,<sup>16</sup> reported a case of a boy of 17 of stocky build, in whom the first tumor was noticed at 4 years, and who presented growths on the upper arms, knees and legs. All the joints were enlarged, and the bones of the hands and feet were short, stubby and nodular. On the inner aspect of the right arm was a cauliflower chondro-osteoma the size of a cocoanut, which had grown markedly during the past three years.

14. Vaughan, R. T.: Multiple Exostoses: A Hereditary Affection of the Bony Skeleton, *Tr. Western Surg. Assn.*, St. Louis, 1913; abstr., *THE JOURNAL A. M. A.*, Jan. 17, 1914, p. 231.

15. Carman, R. D., and Fisher, A. O.: Multiple Congenital Osteochondromata, *Ann. Surg.*, 1915, *Ixi*, 142.

16. Percy, N. M.: Multiple Chondro-Osteoma, *Surg., Gynec. and Obst.*, 1915, *xx*, 619.

This was removed by operation. The boy's grandfather, who was born in Holland, was said to have been affected with the disease, and Dr. Percy investigated his descendants. He found that these numbered 113, of whom 26 were affected, 73 not affected and 14 unknown. Of those affected, 22 were males and 4 females. Transmission through affected males and females was about in the relative proportion of those affected, but in two cases the disease was transmitted through unaffected females. This family tree, which includes four generations, is the first tree worked out in this country, and deserves further serious study.

In the discussion of Percy's paper, Bevan stated that there were many cases on record in which multiple ossifying enchondroma had caused a spinal cord lesion. Ochsner stated that when animals have these enchondromas, a large proportion of the offspring have the same form of tumors. M. L. Harris described a typical case with generally distributed tumors. There was a large growth about the lumbosacral junction with paraplegia. Operative removal did not relieve the paralysis. Bedsores and gangrene developed, and the patient died.

In 1915 I presented a review<sup>1</sup> of the subject based on the study of about 600 cases reported in over 300 articles, and the particular pathologic study of a section removed from an affected epiphysis in a growing child. I stated the belief that the disease was a distinct clinical entity, characterized by (1) the occurrence of multiple, more or less symmetric cartilaginous and osteocartilaginous growths within and on the skeletal system, generally benign, and resulting from a disturbance in the proliferation and ossification of the bone-forming cartilage; (2) the occurrence of certain typical distortions and deformities of the skeleton, and (3) the demonstration of inheritance in a large proportion of cases. To avoid the confusion which exists at the present time as the result of the

multiplicity of terms by which the disease is known, I suggested the descriptive name of hereditary deforming chondrodysplasia. The review included a consideration of the terminology, occurrence and distribution, heredity, pathology, etiology, symptoms and complications, and treatment.

Ashhurst,<sup>17</sup> in 1916, reported a series of thirteen cases. Two had previously been reported by Dr. Davis, and two Dr. Ashurst had not seen but reported from hospital records. The first patient was a girl, aged 4 years, with typical deformities, including subluxation of the right radial head. Case 2 was a man of 20 who presented ulnar deviation of the carpi. Case 3 was a negress of 11 who had a short left forearm and double pes valgus. Case 4 was a boy of 17, in whom the left knee showed outward bowing and relative increase in length. Cases 5 and 6 were two brothers of 15 and 13 years; a younger brother was said to be affected. Case 7 was a boy of 14, who had paralysis of the left ulnar nerve evidently due to pressure of the bony mass in the neck. In this boy the midpoint was half way between pubis and umbilicus. Case 8 was a man of 30, in whom the exostoses were first recognized a year before, following an attack of rheumatism. Dr. Davis in this case removed an exostosis of the left femur which was pressing on the sciatic nerve. Case 9 was a girl of 7; Cases 10 and 11 were the cases reported by Dr. Davis; Case 12 was a boy of 16, and Case 13 a man of 34.

Marshall,<sup>18</sup> in 1916, reported a case in a young woman. This patient will be described later (Case 10).<sup>19</sup>

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17. Ashurst, A. P. C.: Multiple Cartilaginous Exostoses (Hereditary Deforming Chondrodysplasia), with Notes of Nine Hitherto Unpublished Cases, *Ann. Surg.*, 1915, lxiii, 167.

18. Marshall, H. W.: A Case of Multiple Cartilaginous Exostoses, *Am. Jour. Orthop. Surg.*, 1916, xiv, 346.

19. Since this paper was written, A. V. Moschcowitz (*Ann. Surg.*, 1916, lxiii, 749) has reported a typical case in a man of 31, in whom an osteochondroma of the left femur of considerable size projected into the popliteal space, producing cyanosis and coldness of the extremity through interference with the blood supply.

There are doubtless other articles and case reports which I have not come across, just as there are undoubtedly many recognized cases which have not been reported.

PERSONAL CASES

CASE 1.—*History.*—Miss B. T., white, aged 11, entered the Children's Hospital, Nov. 6, 1914. She was born in Beverly, Mass. Father a French Canadian. Father, mother and six other children living and well. Detailed family history not obtained. She was an 8 months' baby, fourth child and very diminutive. Had breast milk for nine months followed by cows' milk and general table diet. She has always been a weak child. Began to walk at 19 months. Whooping cough the only disease of childhood. The deformity of forearm was first noticed at 6 months; it has become more and more prominent with time. The flat feet have been noticed since child began to walk.

*Physical Examination.*—The patient is fairly well developed and nourished, possessing several malformations. The head is normal in size and shape. Pupils react to light and distance. Eyes show no exophthalmos, strabismus or nystagmus. The throat is clear. The teeth are bad and tongue shows large papillae posteriorly. Ears and nose normal. Neck shows prominent cervical glands which are not tender. Chest narrow below, with prominent costal margins. The breasts are slightly full, with nipple depressed. Lungs resonant throughout, no râles or bronchial breathing. Heart slightly enlarged to the left, no murmurs made out. Abdomen normal. Liver extends  $1\frac{1}{2}$  inch below the costal margin. Spleen cannot be felt. There is no skin rash. Reflexes are brisk.

Urine alkaline, no albumin, sugar or acetone. Von Pirquet reaction positive in nine minutes to the human, and in three minutes to the bovine. Blood examination: Leukocytes, 6,900; polymorphonuclears, 66 per cent.; lymphocytes, 34 per cent. Wassermann reaction negative.

*Local:* Patient stands with slight left dorsolumbar scoliosis, with both shoulders thrown forward, a mild degree of knock-knee on each side, and the feet everted. She walks with a rather uncertain gait, throwing her weight on the inner side of the feet, especially on the right. The face is symmetrical, and shows no deformities. Motions at the right shoulder joint normal. The outline of the right elbow is distorted. The forearm can pronate, supinate, flex and extend normally, but the head of the radius is subluxed outward and is greatly increased in size over normal. Muscle power is good, however. Joint motions are free and there are no contractures. Both bones of the forearm are unusually short and to palpation feel thicker than normal. At the wrist,

motions are free. There are no contractures and muscle power is good. The styloid process of the ulna is, however, at least 1 inch above the styloid of the radius and there is a distinct gap below the end of the ulna and the wrist joint. The lower ends of both bones are oversize and there is a slight inward bowing of the ulna at about its lower third. The left arm shows free motions at the shoulder, good muscle power and no contractures. At the elbow the outline of the joint is distorted. The head of the radius is subluxed externally and posteriorly, and is greatly increased in size. The motions of flexion and extension, pronation and supination are free, and there are no contractures. The forearm shows considerable bowing of both bones. At the wrist the ulna is short, the styloid process being at least 1 inch above the radial styloid; the lower ends of both ulna and radius are increased in size. Muscle power is good in all groups, and there are no contractures. The hands are rather small, and the fists cannot be more than half clenched, on account of the obstruction offered by the enlarged extremities of phalanges and metacarpals. At both hips the trochanters are on Nélaton's line, joint motions are free and muscle power good. At the knees muscle power is good. There are no contractures, and joint motions are free. At the right ankle the internal malleolus is unduly prominent and the whole foot is held everted; joint motions are free, and muscle power good in all groups. There are no contractures. The left ankle is held somewhat in the same position as the right. The internal malleolus is abnormally prominent. There are no contractures and muscle power is good in all groups. Reflexes: Knee jerks present on both sides. No clonus, Babinski, nor Oppenheim. Right arm: acromion to internal condyle  $9\frac{1}{8}$  inches. Left  $9\frac{1}{4}$  inches.

Left leg: length,  $28\frac{1}{8}$  inches. Circumference: thigh,  $12\frac{3}{4}$  inches; calf,  $8\frac{3}{4}$  inches.

Right leg: length,  $28\frac{1}{4}$  inches. Circumference: thigh, 13 inches; calf  $8\frac{3}{4}$  inches.

Nov. 20, 1914, I excised, under ether, a strip of bone 2 inches long and  $\frac{1}{4}$  inch wide from the lower end of the left radius, the strip running longitudinally, so as to include the epiphyseal line. The cortex was found thin and hard and the marrow was very soft, and contained grayish-white flecks. This specimen was examined by Dr. Ash of the pathologic department of Harvard Medical School, who made the following report:

"There is a slight thickening of the periosteum, and while there is a very active osteogenetic layer, the cortical bone is very thin. In the periosteum just above the epiphyseal line is an area of young cartilage increasing the thickness of periosteum four or five times. The epiphyseal tissue is greatly disarranged; the columns of cartilage cells are very irregular; there is a distinct and irregular increase in the

cartilaginous tissue, and the cells in this proliferated cartilage are quite irregular in grouping. Irregular splotches of calcification are present in this cartilage. In some of the lacunae the bone is laid down. This tissue gives the impression of tumor in the nature of a chondroma. This, a typical excessive growth of cartilage, of course, will account for the enlargement, and the imperfect osteogenesis for the porosity of the epiphyseal ends. The ectopic cartilage is apparently a subsidiary feature."

*Roentgenologic Examination:* Cranium negative; sella turcica of normal size. Thorax free, except for slight irregularities in lower ribs. Marked lateral curve in lumbar spine. Slight irregularities about sacro-iliac articulations. Both ilia show a peculiar series of radiating striations about the crests. Clavicles and scapulae are free, and the humeral heads show slight thickening. The lower third of the shafts of the humeri show some deviation from normal contour. The circumference is lessened, and the bone is bent. The humeral condyles show mottling. The ulnae are relatively short, bowed concave forward, and at the lower end present a large irregular bulbous enlargement, in which the epiphyseal line is lost. The radii are straight, with the upper end dislocated outward and upward, so as to form a marked projection at the level of the outer condyle. The lower end presents a similar irregular cystic-like enlargement, but the epiphysis is present intact, though relatively small. The entire carpal articulation is carried on the radius. The distal ends of all the metacarpals and the proximal ends of the first two rows of phalanges show the globular striated enlargements referred to. The femoral heads are squat and thick, with flat epiphyses and prominent trochanters. There is mild genu valgum in both legs, and the diaphyseal extremities of tibiae and fibulae are widened and irregularly striated; the fibulae are relatively short, so as to destroy the ankle mortise, and the tarsus is offset outward to create an extreme pes valgus. The heads of the metatarsals, and the proximal metaphyseal extremities of the first phalanges show the globular vacuolated enlargements already seen on the fingers. On the left foot the first and third digits show comparatively slight involvement, and are accordingly relatively longer than the other digits.

The deformities in this case consist in a scoliosis, shortening and bowing of the forearms, ulnar deviation of the hands, dislocation of the heads of the radii, moderate knock-knee, extreme tarsal valgus, irregularity in length of toes, and shortness of stature. There are no exostoses, few hyperostoses, and the deformities are symmetrical.

The roentgenograms were taken at the Children's Hospital.

**CASE 2.—History.**—Miss J. W., white, aged 21, bookkeeper, was born in Boston of Jewish parents. The father was born

in Hungary, a tailor, of ordinary height. He died of old age in Boston, at 82. His father died of tuberculosis. No knowledge of deformities in family. Mother born in Austria, living and well at 46, of ordinary height. Her father living, 82 years old. Mother died of old age at 75. No knowledge of deformities. One brother died of hydrocephalus at 1½ years. No other brothers or sisters. The patient had measles in childhood, and nervous indigestion for several years. Rheumatic pains in joints whenever exposed to a draft, or at a change of weather, for years but never so as to be confined to bed. Menstruation at 14.

*Present Illness.*—At 2 the patient broke a leg, and was taken to the Children's Hospital (record not found). The peculiarity in the skeleton was then noticed. At 6 she was again taken to the Children's Hospital on account of crookedness of fingers. Record as follows:

Child rather small. Heart sounds clear. Apex beat  $\frac{1}{2}$  inch inside and below nipple line. No increase in area of cardiac dulness. Spleen to be felt just below margin of ribs. Head prominent. Fontanels closed. Slight frontal protuberances.

Clavicles show exaggerated anterior curves, sharp prominences at insertion of sternomastoids, and a sharp prominence at outer end of left. Marked beading along line of junction of ribs and cartilages, particularly at eighth and ninth on left and seventh on right.

Both upper arms show marked prominence immediately in front of insertion of deltoids, particularly the left. Enlargement about upper end of left radius. On anterior aspect of each radius in region of lower epiphysis is a marked prominence, projecting forward on the left as a spur about  $\frac{1}{4}$  inch long. About 1 inch above styloid process of each ulna is a spur, more marked on the left; metacarpus normal. Terminal phalanges of fingers rather broad. Slight enlargement of first phalanx of right forefinger. Marked enlargement of middle phalanx of left little finger, and first phalanx of left middle finger.

Spine absolutely flexible; patient can touch floor without bending knees. Pelvis shows no abnormality.

No limitation of motion in hips. Some prominence on anterior aspect of each femur, just above middle. Adductor tubercles can be felt slightly increased and projecting upward. Immediately inside each patella tubercle is a marked rounded prominence, half as large as a horse-chestnut, extending somewhat backward. An enlargement is to be felt below the head of each fibula. Knees can be very slightly hyperextended, but in flexion they lock firmly at an angle of 140 degrees. One inch above both outer malleoli are marked sharp bony prominences, encircling the bone to a slight extent. Feet and toes are normal. Normal mobility in joints of foot and ankle.

Roentgenograms were taken, and the diagnosis of multiple exostoses made.

At 10 years, the patient went to the Massachusetts General Hospital for treatment of deformity. Roentgenograms were taken. Three years later she went again, on account of weakness in the ankles. Soon after that she went to the Boston City Hospital, where she was given plates to wear in her shoes. She says that she cannot walk without arch supports; the present ones were made by a private physician.

March 14, 1913, she was admitted to the Nerve Service at the Boston City Hospital, having previously been under treatment at the medical and nerve outpatient departments. She complained of extreme nervousness, continuous nausea, headaches and vomiting spells, occurring for several years. She worried a great deal and was melancholy over her condition.

An exhaustive nerve examination showed nothing abnormal. Stomach contents normal. Urine negative. Wassermann and Noguchi reactions negative. Physical examination included the following note: Well nourished. Some deformity of the extremities. Internal malleoli very prominent, also epiphyseal ends of tibiae and femora, forearms and humerus. Legs and arms short, particularly lower leg and forearm. Roentgenograms taken.

After two weeks' stay she was discharged not relieved to the nerve outpatient department. Diagnosis: gastric neurosis, achondroplasia fetalis.

*Physical Examination.*—I first saw her, May 7, 1915. I found her a bright looking girl of excellent mentality. She had, in fact, won some distinction during her high school course. She had been working steadily as a bookkeeper during the past three years. The nausea had continued, but it was relieved by eating. She had had no benefit from treatment and was convinced that it was purely nervous. She had occasional twinges of pain in the joints. Wrists are weak, particularly the left, so that at times she can hardly lift a sheet of paper. She walks only with arch supports.

She is short in stature, measuring 4 feet 8½ inches. The middle point is half way between pubes and umbilicus. The arms are noticeably short, the right reaching a third way down the thigh, and the left being shorter still. Measurements from tip of acromion to the tip of middle finger are: right, 23½; left, 22¼. Musculature is good. Both arms hyperextend about 15 degrees at the elbow. Both wrists are loose in adduction, the left to a higher degree than the right, and just above the carpus the radius can be palpated on the inner as well as the outer aspect. Fists can be clenched tightly with the appearance of one or two small double knuckles. Wrists not greatly enlarged. Patient says that she formerly had a large mass on the ribs on the right side, but this disappeared four years ago, after she began to wear corsets. It is not to be felt now.

Moderate degree of knock-knee. Large rough lumps to be felt above and below both knees. There are lumps and irregularities on the lower ends of both tibiae and fibulae. Slight degree of flatfoot, but on the whole the ankle mortise is well maintained.

*Roentgenologic Examination:* Cranium negative, normal sella turcica. Thorax shows a slight caving in of the ribs, especially on the left; enlargement of the costochondral junctions (rosary), and a tear-drop exostosis on the lower border of the fifth left rib, one third of the way around from behind. No scoliosis. Some irregularity about sacro-iliac articulations. Pelvis shows very wide ilia, and unusually thick pubes and ischia, with a relatively small superior strait. Clavicles thick, with enlargement at outer ends. Scapulae not remarkable. Upper ends of humeri show irregular enlargement of diaphyseal extremities, with longitudinal striation. About one third of the way down the shaft of the humerus on both arms is a moderate enlargement, from which project rounded stalactite exostoses. Elbow joints appear normal. The ulnae are relatively short. In a plate taken at the age of 6 the lower ends of the ulnae are irregularly enlarged, but do not reach to within an inch of the carpal articulation. The epiphysis cannot be distinguished. The lower ends of the radii are somewhat enlarged and irregular, particularly the right; the epiphyses are clear cut, but small. In the recent plates (taken at 18 years) the irregularities are much less, the bones showing a denser structure, with a straighter outline. There is no evidence of epiphyseal line. The right ulna ends in a point, which articulates laterally with the radius, and on the left it resembles a spear head. There is a fine retrodirected exostosis on the outer aspect of the lower end of both radii. The metacarpals and phalanges in the 6 year plate show irregular enlargement and vacuolation of the diaphyseal ends, most marked in the metacarpals. There is a spur on the left forefinger; the right middle finger is disproportionately long, and the distal phalanx subluxed inward. The later plate shows the same conditions except that the bone is denser and the outlines less irregular, and the epiphyses have disappeared in moderate globular striated enlargements at the ends of the bones. At the hips, the femoral necks are short, and very much increased in width; the outlines are irregular and the trochanters prominent. The shafts are of normal contour down to the lower ends, which are squared, striated longitudinally, and present hooklike exostoses, directed upward. The same lengthening and squaring of the diaphyseal extremity is apparent in the upper end of the tibiae, but here the pair of stalactite exostoses are directed downward. The upper ends of the fibulae show marked irregular globular enlargement, cystic in appearance, much larger on the left. There is moderate genu valgum. The shafts of fibulae and tibiae are clear. Their lower ends

are broadened, and there is a long irregular pseudarthrosis between them. The fibulae are relatively short, but the axis of motion of the ankle joint is not disturbed. In none of the late plates is there evidence of an epiphysis.

The deformities in this case consist in disproportionate shortness of stature, deformity of thorax, rosary, shortening and bowing of forearms, ulnar deviation of the hands, subluxation and asymmetry of fingers, moderate genu valgum, moderate pes valgus, enlargement of the diaphyseal extremities at shoulder, knee and ankle, a few exostoses, and a chondromatous enlargement of the upper end of the fibula. The occurrence is symmetrical, although the degree varies slightly.

The early plate was taken at the Children's Hospital, the later plates at the Boston City Hospital.

CASE 3.—*History.*—Mr. F. R. J., aged 56, white, janitor, first seen May 11, 1915, in the orthopedic outpatient department of the Massachusetts General Hospital, by courtesy of Drs. Brackett and Low, was born in Vermont, of American parents. Father died in 1910 at 82, mother died in 1915 at 87. Whole family short in stature. Father and mother both of same height as patient. One sister died in infancy. One brother living and well, of normal height. Grandparents American born. No history of deformities or exostoses.

The patient had measles and pertussis as a child. Denies venereal diseases; does not use alcohol. At 7 or 8 years outgrowths and deformities were first noticed. Taken to local physician who said that patient had exostoses and would probably be a cripple. At 14 an extensive crop appeared, growing "as fast as he grew," some being painful or tender at times. Went under treatment with a "quack" doctor for three years; he stopped the pain and stopped the bunches from increasing in size. Since then he has had no new bunches, no increase in size, no disappearances.

Had occasional growing pains or rheumatism when young; at 19 inflammatory rheumatism, in bed one week.

Has always been able to do heavy work; when younger could run upstairs with a bag of corn over his back. No trouble with walking. No bunch is large enough to interfere with the free action of any joint.

March 29, 1914, patient was taken with an attack of acute indigestion on the street, and was carried to the Boston City Hospital. He stayed one week under the care of Dr. Withington. Diagnosis: acute indigestion, temporary glycosuria. The record gives the following as regards his deformities: large exostosis on left humerus 2 inches from upper extremity. Forearms much shortened, and markedly bowed, with convexity on ulnar side. Ulna shows many exostoses, radius none. None on clavicles or ribs. Legs same as arms. Femora equal and normal. Measurements from anterior superior spine to top of patella, 16½ inches. From top of

patella to internal malleolus, left  $15\frac{1}{4}$ , right 15 inches. Large exostoses on inner sides of lower ends of both femora. Right tibia and fibula show two or three exostoses. Roentgenograms were taken.

*Present Illness.*—About eighteen months ago the patient fell down stairs and injured right knee. Since then he has had considerable trouble in walking. Knee is lame, so that he has pain from time to time, and cannot walk far. Went to the surgical outpatient department at the City Hospital a year ago on this account. Lately he has gone to the orthopedic outpatient department at the Massachusetts General Hospital, where he is now under treatment.

*Physical Examination.*—The patient is a genial, intelligent-looking American. Height 5 feet, 2 inches. Middle point is 3 inches above pubes. Finger tips reach to point short of midthigh.

Upper arms not remarkable. Lower arm short and curved. No dislocation of radial head. No club hand, although entire articulation is carried on radius. Hand is stubby, no limitation in closure, but both fourth fingers are short, the same length as little fingers.

Stands with considerable knock-knee, greater on the right, approximating 45 degrees. The right knee, probably in part as the result of the injury already noted, allows of lateral mobility of about 20 degrees. Both knees very large, with palpable exostoses. Lower legs: fibulae short, with dislocation valgus, more marked on right. No limitation of motion at knee or ankle. Good function knees and ankles, except at right knee, as noted.

*Roentgenologic Examination:* I have plates only of the arms and legs. The shoulders show the characteristic striated elongation of the upper end of the humerus. The ulnae are short, curved, and articulate with the inner surface of the radius. The lower ends of ulna and radius are irregularly enlarged, and of thinner texture than the shafts. The knees show marked valgus, elongation and squaring of the diaphyseal ends, with irregular exostoses at the corners, projecting upward on the femur and downward on the tibia. The upper ends of the fibula are enlarged and thinned, and run by direct fusion into the tibiae. The lower ends of the tibia and fibula are distorted; on the right there is fusion of the two bones. On the left there is a pseudarthrosis. The fibulae are short; there is a fair ankle mortise, but the axis of motion of the astragalus is oblique, rather than horizontal.

The deformities in this case are disproportionate shortness of stature, shortening and curvature of forearms, mild ulnar deviation of the hands, shortness and asymmetry of fingers, knock-knee, pes valgus, hyperostoses and exostoses about joints. The deformities are symmetrical.

The plates were taken at the Boston City Hospital.<sup>20</sup>

**CASE 4.—History.**—Mrs. E. H. H., aged 20, white, first seen, May 25, 1915, at her home in Somerville, through the courtesy of Drs. Binney and Kimpton, was born in Montreal, Canada. Father was an Englishman, from Sussex. He was about 5 feet 8 inches in height, and is not known to have had any deformity. He died in 1910 at 48. Mother was a French Canadian, born in Montreal, of normal height, and is not known to have had any deformity. She died in 1915 at the Boston City Hospital. The family consisted of eleven children, three boys and eight girls, of whom the patient is number 5. One boy and one girl died in infancy. The others are living and well, and are said to present no deformity. This patient is the only one who is distinctly below normal height.

The patient had the diseases of childhood, but was never seriously sick. Broke right leg at 2 years. Married less than two years; husband is an American, living. Has had one stillbirth at 8 months, a child of 9½ pounds, after a hard time. Another baby is expected in June, 1916.

**Present Illness.**—Patient first noticed the trouble at about 7 years. Had had cramps in the knees for about a year after this, which then disappeared. Never had rheumatism. Used to walk with inner side of ankles almost touching the ground, wearing out the inner sides of the shoes, but has had no trouble this way for several years, as ankles have become stronger. The bunches and deformities increased up to 11, when patient was struck by lightning and rendered unconscious for an hour. Since then patient has noticed no further progression in the condition. She has never been bothered by the trouble or disabled in the least. Started to work in rubber factory at 13, and continued until marriage at 18. She thinks that the excessive length of the middle fingers is due to her constant use of these fingers in running a certain machine. She is left handed. Early in March, 1915, she fell downstairs and injured left shoulder so that she could not move it without pain. March 29, came to the Boston City Hospital, where limitation of motion in abduction was found, with practically no tenderness. Under massage condition improved rapidly. Roentgenograms were taken.

**Physical Examination.**—Patient is 5 feet 5½ inches in height. Middle point is just above pubes. The right arm is 25 inches and the left arm is 24¾ inches. The outer ends of the clavicles are rough, and on the right there is a sharp knob. The forearms are short, somewhat curved, right, and

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20. September 26, this patient, employed as an elevator man in a Boston hotel, suffered a severe crushing injury of his right leg above the ankle. I performed an amputation, from which he is recovering uneventfully. The specimen is being studied at the pathologic laboratory of the Harvard Medical School.

sharp curve left. Wrists enlarged, but no disability. Can close fists. Middle fingers long.

Moderate knock-knee; some pes valgus, but feet seem good from point of view of function. Ankles enlarged. Large knob on the outer side of femur above the left knee.

*Roentgenologic Examination:* Cranium negative; sella turcica normal in size. Thorax shows a very pronounced caving in of the ribs on both sides. There is an irregular enlargement of several of the ribs, particularly the first four on the left and the first two on the right. There is a synostosis between the third and fourth, left. The spine shows a double scoliosis. The sacro-iliac joint and pelvis are clear. The clavicles are thick and enlarged at both extremities. The scapulae show small irregularities; upper end of humeri show small united epiphyses. On the left the contour is normal, but there are several fine exostoses, and on the right the shaft near the upper end shows irregular cystic enlargement with small exostoses. The lower halves of the shaft are free, and the elbow joint is normal. The forearms are short with a very marked relative shortening of the ulnae. The radius is curved and its lower end irregularly enlarged. There is no epiphyseal line apparent. The articular surface of the radius stands at an obliquity of about 45 degrees to the shaft, making a potential manus vara, with a very weak wrist. The fingers show globular enlargement at the metacarpophalangeal articulations and the first interphalangeal articulations particularly. The middle fingers of both hands are relatively long. The upper ends of the femur are thick, with short, thickened necks. The shafts are free down to the lower diaphyseal extremities, which are square, elongated, striated longitudinally and present several exostoses, directed upward. The upper diaphyseal extremities of the tibia and fibula are similarly squared and elongated and present exostoses directed downward. The lower diaphyseal extremities are elongated and present pseudarthroses. The ulnae are relatively short, and the tarsi are in valgus.

The deformities in this case are disproportionate shortness of stature, scoliosis, deformity of thorax and ribs, shortness and curvation of the forearms, ulnar deviation of the hands, knock-knee, pes valgus, asymmetry of fingers, and hyperostoses and exostoses about joints. The deformities are symmetrical. There is no evidence of epiphyseal line, except at the upper ends of the humeri.

The plates were taken at the Boston City Hospital.

CASE 5, 6 and 7.—*History.*—Family D. Father, Charles D., first seen, Feb. 10, 1916, at the age of 46. His father was born in 1804, in Isle of Wight, England; he died in 1883. He was a heavy, thick-set man, not tall, but slightly taller than the patient. He was a shipper by trade, and lived in New York City. He was married twice and had about seven chil-

dren by his first wife. Of these the patient knew five, four boys and one girl. The girl, who was the youngest in the family, is still living at the age of 67. Of the four boys three were telegraph operators, and they died at a ripe old age. The patient is one of three children by the second wife. She was born about 1835 in Brooklyn, of American parents, and died in 1883. She was the same height as her husband. The first child was a girl, who now lives in Massachusetts. She has twelve children; two died in infancy. Examination of her and her family shows no exostoses, although two children show other skeletal peculiarities. The patient is the second child, and he was born in 1870, his father at that time being 66 years old. The third child is a son, who is alive. He is not known to have any deformity.

The patient had no knowledge of any deformity until the age of 16, when in wrestling, he "snapped" his right wrist. He went to a doctor, who said no bones were broken; he wore a splint for three weeks, and ever since then his wrist has been crooked. Patient has had no complaint from his deformity, except this partial disability at the wrist, and has been a telegraph operator for twenty-four years.

*Physical Examination.*—The patient is a stockily built man, below medium height, midpoint elevated. The joints present the characteristic hyperostoses, and both wrists show deficiency of the radius, and ulnar deviation. The forearms are short and curved, and the hands small. Moderate knock-knee and flatfoot.

The mother, Mrs. Charles D., is not affected. She was born in Boston of Irish ancestry about 1870. Her father died at the age of 36 of pneumonia, when she was a child. Her mother died at the age of 56 in 1894, of heart trouble. She has two brothers and two sisters living, married, with children, seven in all, and none have any deformity. She is, herself, of medium height, thick-set. She has had seven children, of whom four are living.

First child, Julia, died in 1910, at the age of 11½ years, of heart failure complicated by chorea. No deformity.

Second child, Helen, aged 17, affected.

Third and fourth children, twins, boy and girl; seven months' babies; girl died at 1 week, and the boy at 11 months.

Fifth child, Charlie, born in 1902, affected.

Sixth child, Mary, 9 years old, no deformity.

Seventh child, Thomas, 6 years old, no deformity.

Helen D., seen Feb. 6, 1916, aged 17, well and strong, 5 feet 4½ inches in height, midpoint not measured, has had serious trouble with left arm, which is markedly curved and is very weak at the wrist, requiring for some time treatment with splints. Does clerical work. She presents the typical hyperostoses, curvation of forearms, deficiency of radius at the wrist, ulnar deviation, etc.

Charles D., Jr., came to the Children's Hospital, Oct. 3, 1906, at the age of 4, for treatment of an inflammatory mass under the chin. The note for Dec. 19, 1906, says that "two days ago mother noticed bony lumps on the left scapula and on the left second metacarpal which were not sore, and examination was made which showed bony nodules on the left scapula and the left second metacarpal, also on the left femur, tibia and fibula in the region of the epiphysis. Small nodules apparent on the ribs and a few on the right femur."

After some effort, the boy was located through the assistance of Dr. Tenny. Examination, Feb. 6, 1916, showed a healthy looking, thick-set boy of 14 years. He was 4 feet 6½ inches tall, midpoint elevated, and presented no marked deformity on superficial examination. Close observation showed shortening of the forearms, large hyperostoses about the knees and thickening at the ankles. He had no complaint.

*Roentgenologic Examination.*—Charles D., Sr.: I have plates of his arms and legs, taken at the age of 46. Lower ends of humeri negative. Just below the upper end of left radius is a thick spur, extending downward. Left ulna relatively short, and ends in a spear point which articulates with radius but takes no part in carpal articulation. Radius moderately curved, lower end broadened; very little vacuolation. Carpus shows moderate ulnar deviation. Right elbow shows a thick spur projecting downward from tip of coronoid process of ulna. Ulna relatively short, ending in a blunt point, articulating with the radius laterally, is spurred at point of contact. Radius markedly bowed, carpal articulation being at 45 degrees from line of shaft. Carpus deviated to ulnar side. Lower ends of both femora show marked squaring with wavy outlines and several blunt spurs. Like the older bones in Case 3, the longitudinal striations are less marked, the bone is dense, and there is none of the vacuolation seen in the younger cases. The upper end of tibia and fibula are also irregularly enlarged, with rounded contours. The inner condyles of the tibiae present spurs directed downward. The fibulae are relatively short, the left synostosed to tibia, the right in close irregular contact with it. The ankle mortise is poorly maintained, and the feet are in valgus.

The deformities in this case are disproportionate shortness of stature, short curved forearms, with ulnar deviation of wrists, small hands, slight knock-knee, marked structural pes valgus, with hyperostoses and exostoses about joints.

Helen D.: I have plates only of arms and knees, taken at age of 16. Elbows are normal. Shafts of radius and ulna clear, down to lower extremities. Ulna relatively very short, and both radius and ulna bowed with concavity ulnrad. Ulna ends in a spear point tipped by a tiny epiphysis, partly united. Lower end of radius broadened with irregular outline and thin texture. Epiphysis very thin, mostly united. Left forearm worse than right. Knees show some valgus,

broadening of lower end of femur, irregular scalloped outline, with short spurs. Tibia and fibula similarly enlarged. Epiphyses somewhat thinned, irregular in outline, completely united.

Deformities in this case are: shortness of stature, shortening and curvation of forearms, ulnar deviation of wrists, hyperostoses and exostoses about articulations, irregular epiphyses with premature union.

Charles D., Jr.: I have plates of the leg taken at 4 years, and of arms and legs taken at 13 years. The early leg plates show rather narrow and thin epiphyses at the knee, and beginning "squaring" of diaphyseal ends of femur and tibia. The upper end of fibula shows bubble-like vacuolations. The shafts are clear, and the lower ends not abnormal, except for slight broadening of diaphyseal ends, thinning of epiphyseal lines, and one effort at spur formation on the fibula. The later plates show the "squaring" effect extending some way up the shaft. The bone is denser, striated longitudinally, with wavy outlines, and there are several blunt spurs. The upper end of the tibiae are squared, with spurs directed downward from the inner corners. The irregular fibular ends are lost in the irregular contour of the tibia. The vacuolization is disappearing in the denser structures of the bone. The epiphyses are normal in outline, rather thin, and partly united. The shafts are clear, but the lower ends are somewhat enlarged, and there is a long irregular line of contact between tibia and fibula; and there are short spurs. The epiphyses are not united. The fibulae are relatively short. The forearms show, on the right, a short curved ulna, ending obliquely in a point, capped by a small deformed epiphysis. The lower end is irregularly broadened, and 2 inches up from the tip is a thick spur extending horizontally across the interosseous space to articulate with a spur on the radius. The lower end of the radius is broad, carrying a distorted epiphysis, partly united. The left ulna is short, and, as on the right, takes no part in the carpal articulation. The shaft is free except for a pediculated osteochondroma larger than a walnut, which projects anteriorly from the junction of the middle and lower thirds. The epiphysis is distorted. The lower end of the radius is irregularly broadened, and its epiphysis is slightly distorted.

The deformities in this case are shortening and curvation of the forearms, with ulnar deviation of the wrists, spurs on metacarpal and scapula, hyperostoses about joints, osteochondroma of ulna, and distortion of epiphyses.

The early plates of Charles D., Jr., are from the Children's Hospital. The remainder were taken by Dr. Arial George.

CASE 8.—*History.*—J. E., boy, aged 7, white, was admitted to the outpatient department of the Children's Hospital, Feb. 18, 1905. The mother was tuberculous. Father and two other

children well. No heredity ascertained. Irish ancestry. The patient was premature at seven months, dry birth. Ophthalmia, measles, diphtheria and whooping cough.

At 5½ years abnormal contour of right elbow was noticed. Condition has changed but little since, except that the elbow has increased somewhat in size and there has been an increase in size about the wrist and on the anterior surface of the lower portion of the forearm. No pain or tenderness.

*Physical Examination.*—Well developed and nourished. Corneal opacity below left pupil. Right forearm 1½ inches shorter than left. Head of the radius projects under skin, giving the appearance of an outward displacement of the forearm. Some enlargement just below elbow over upper end of ulna. On the palmar surface of the forearm at the junction of the lower and middle thirds on the ulnar side is a swelling 1½ inches long, due to the projection outward of a bony mass on the ulna. Length from acromion to external condyle on the right is 8½ inches, left 8¾; length of right radius is 6¼, left 6¾; of the right ulna 5½, left 7½. There is a distinct loss of substance at the lower end of the right ulna. There is marked broadening of the forearm below the elbow. Flexion of the elbow limited to 15 degrees, extension possible to 180 degrees. Pronation slightly limited, supination normal. Right hand smaller than left and weaker.

Roentgenograms were taken, and it was decided to remove the bony growth at the lower end of the ulna, which was done, Jan. 26, 1906. The wound healed by primary intention. Pathologic report, exostosis.

I have endeavored to induce this patient, now a young man of 18, to come in for further examination and roentgenoscopy, but without success. He is a powerfully built youth, of 5 feet 7 inches, with a reputation as a fighter. He has never been inconvenienced particularly by his deformities, although the right forearm "looks as if it had been broken." His father says he is unruly and wilful.

*Roentgenologic Examination.*—I have plates of this patient taken at the age of 7, showing the right arm; the lower end of the humerus is somewhat broadened; epiphysis not united. The ulna is relatively short and thick and the lower end shows a marked increase in size with vacuolization. No epiphysis is to be made out. The radius is long, slightly bowed, with some irregularity about the upper portion of the shaft. The upper end of the radius is dislocated outward and upward to a marked degree. The end shows slight deformity. The epiphysis is not united.

The deformities known to exist in this case are juxta-epiphyseal hyperostoses, dislocation of the head of the right radius, shortening of the forearms with curvation and ulnar deviation, and small hands. The roentgenograms were taken at the Children's Hospital.

## MULTIPLE CARTILAGINOUS EXOSTOSES 195

CASE 9.—*History.*—E. L., boy, aged 12, white, seen May 22, 1916, at my office, was born in Cambridge, Mass., of Anglo-American parents. Father well at the age of 42, height 5 feet 6 inches, printer, born in Rockland, Maine. He has three brothers and one sister all below medium height, except the oldest. The oldest has one child. His father died of paralysis in the fifties, and his mother is living and well, in the sixties. No history of deformity.

Mother living and well at the age of 48; born in Rockland, Maine; 5 feet 6 inches in height. Her father was a sea captain, above medium height. He wore a corset for some "spinal trouble," and died in 1885 of Bright's disease at 53. Her mother was a delicate woman who died at 52 in 1890 of gastric cancer. She was above medium height. Her one sister is living and well. No history of deformity. She was married at the age of 17. No miscarriages, has lost no children. One other child beside patient, a girl of 15, living and well, without deformity.

Labor was normal. Breast fed for three months, then malted milk. In early years was delicate. Pertussis at 4, chickenpox at 5, mumps, measles, and bronchitis two or three times. Ringworm. Otherwise strong and well. No rheumatism. At 3 months a lump was noticed on the upper end of the right tibia. This developed in size and other projections appeared elsewhere, so that at 2 years the child was taken to the Children's Hospital. The physical examination was as follows:

Sept. 6, 1905. Head rather large and square. Fontanels closed. At the inner side of the upper end of the right tibia is a bony tumor with a small pedicle, size of a hazelnut. A prominence can be felt just above the lower end of the right ulna, a slight prominence above the lower end of the left fibula, another on the anterior surface of the outer end of the right clavicle and one on the first phalanx of the left middle finger. Marked knock-knee, with slight hyperextension of the knees.

Under observation over several months it was noted that some of the tumors were increasing rapidly in size. Aug. 31, 1908, it was noted that the boy was somewhat round-shouldered. Aug. 14, 1912, examination was as follows: Poorly developed boy, fairly well nourished, showing multiple, painless nodules on many of his bones (ribs, tibiae, femur, ulna, etc.) which are evidently exostoses. Bony growths apparent around ankle joints. All foot motions free. Both feet pronated, the left markedly so. Gunstock deformity of left arm, scoliosis.

Roentgenograms were taken and treatment for scoliosis and flatfoot begun. Since this date child has reported to the Children's Hospital at intervals.

Mother states that there has been no pain or disability in connection with any of the joints, but that lately there has

been a complaint of some lameness in the right knee. There has been no inflammation or irritation about the exostoses, except about the outer side of the left ankle, where a sharply pointed exostosis is covered with a small callous. Mother states that one exostosis on the inner side of the right knee seems to be smaller now than it was formerly. Whether or not this is relative and due to the growth of the child she cannot say.

*Physical Examination.*—Intelligent-looking boy, face symmetrical, and of good contour. Mastoids prominent and rough. Angles of jaw free. External occipital protuberance not enlarged. Spur on inner end of left clavicle and outer end of right clavicle. Upper ends of humeri enlarged and irregular. Right elbow and forearm not remarkable. Left elbow presents a condition simulating gunstock deformity; left forearm shortened and ulna curved to a marked degree. Radius deficient at the left wrist, giving an unstable wrist joint with ulnar deviation. Right wrist shows some deficiency of radius, but on the whole a fairly normal joint. Hands small. On the right hand the middle finger is disproportionately long. On the left hand middle finger is short and crooked. Knuckles slightly enlarged. Hips show moderate enlargement and irregular hyperostoses above and below. Knees thick and irregular. The ankles are thick and very rough to palpation, but there is no skeletal valgus. The feet are not remarkable, and present a mild pronation. Legs are straight. The left leg is  $30\frac{1}{4}$  inches long, and the right is  $30\frac{3}{4}$ . The height is  $57\frac{1}{2}$  inches and the middle point is  $\frac{3}{4}$  inch above the pubes.

*Roentgenologic Examination.*—I have plates of the arm and knees of this patient at the age of 8, and plates of the entire skeleton taken at the present age of 12. The thorax shows no abnormality, spine slight scoliosis. Pelvis shows marked irregularity about the epiphyses as well as considerable thickening of bone. Clavicles show marked thickening of the inner ends, particularly on the right. The scapulae show small spurs and irregularities, particularly about the head and neck. The humeri are somewhat thickened and dense at the upper ends, with wavy outline, and the epiphyses are partly united. Elbows: some irregularity in bony structure and in outline about condyle of humerus. The epiphyses are distorted in the early plate and show signs of partial union in the more recent picture. The ulna on the left is markedly shortened and somewhat curved. It ends in a point, which does not take part in the carpal articulation. This point is capped by a small triangular epiphysis. The radius is curved and thickened at the lower end, and the epiphysis is distorted. The right forearm presents a practically straight ulna with slight irregularity in outline at the lower end, and a small epiphysis not united. The radius is slightly curved; both

epiphyses show partial union. The fingers show striation at the metaphyseal ends, with slight disproportionate lengthening of the right middle finger. The hips present marked thickening of the neck with irregular contour in the region of the lesser trochanter and partial union of the epiphysis. The knees show squaring of the metaphyseal ends with striation and spur formation at the corners, a process which is carried further in the more recent plate, the striated portion extending further up on the shaft and the spurs being increased in size. There is slight knock-knee, and the more recent plates show a partial union of the epiphysis. The upper ends of the fibulae are vacuolated and the lower ends are irregular and vacuolated, and in contact with an irregular surface on the outer side of the tibia. The shafts of tibiae and fibulae are clean cut. The fibulae are relatively short. The feet show calcaneal spurs and striation and irregularity of outline at the metaphyseal extremities of metatarsals, and to a less degree on the phalanges.

The deformities in this case are as follows: moderate valgus at the left elbow, shortening and curvature of the forearm, greater on the left, ulnar deviation of the wrists, particularly the left, small hands with asymmetry in length of fingers on the right, moderate genu valgum, moderate pes valgus, disproportionate shortness in stature, and juxta-epiphyseal hyperostoses and exostoses.

The plates were made at the Children's Hospital.

**CASE 10.—History.**—Mrs. A. J. P., aged 25, white, stenographer, seen Jan. 21, 1916, in the orthopedic ward of the Massachusetts General Hospital, by courtesy of Dr. Brackett, was born in Bangor, Maine, of Anglo-American parents. The father and mother are living and well at the age of 49. The father is 5 feet 9 inches tall, but his father was of short stature. The mother is of normal height, and is said to have a bony lump on one leg. One sister and two paternal aunts are the same height as the patient. The maternal relatives died young. There is no other history of deformities. The patient was always well, except for diseases of childhood. The patient menstruated at 13; menstruation is regular; the patient has been married three years; there are no children.

**Present Illness.**—Four years ago the patient noticed a lump on the back of the neck and at the same time small nodules on the hands. Since then the lump has increased in size, and there has been considerable pain on bending the head, localized in the lump and not radiating. Since last summer she has had occipital headaches, particularly when keeping the head forward while at work. She came to the hospital, Dec. 30, 1915, when the following report was made: "Multiple bony tumors on hands and cervical vertebrae. The ones on the vertebrae cause some snapping in neck, and dull occipital headaches; also there are increasing pains at site of tumor.

Motions of neck fairly free. It seems probable that the tumor mechanically interferes with motion enough to cause increasing irritation in future." The record states that the Wassermann, complement fixation test for gonorrhea and von Pirquet reaction are negative.

*Physical Examination.*—The patient is 5 feet 1½ inches in height, light in weight, healthy in appearance, with no marked deformity apparent to superficial inspection. Middle point 2 inches above pubes. Cranial contour normal. Neck shows a tumor size of walnut in median line behind, from fourth to seventh cervical spines. Shoulders not remarkable. Forearms short; shortening relatively greatest in ulna, giving ulnar deviation of hands. Can shut fists tightly, but slight bony projections become apparent on bases of metacarpals and on phalanges. Right hand worse than left. Palms are short and fingers chubby, but symmetrical as to length. Thorax not examined. Spine not examined for scoliosis. Below middle of crest of ilium on both sides bony projections size of walnut. Hips negative to palpation. Moderate sized spurs palpable above and below knees on inner side. Ankle joints slightly enlarged. Slight relative shortening of fibulae. Slight pes valgus, moderate flat-foot.

Tumor of neck was removed, January 22; pathologic report, "osteochondroma."

*Roentgenologic Examination.*—Cranium not taken. Distortion and vacuolation of second, third and fourth cervical spines; in the top of the fourth there is a rough depression in which fits the irregular process of the third. The tip of the fifth spine ends in an osteochondromatous enlargement. Roentgenoscopy of the thorax shows irregularity in the upper dorsal vertebrae and an exostosis on the right scapula. The lower lumbar spine shows some irregularity in the transverse processes and laminae of the fifth and in the upper portion of the sacrum. There is a considerable irregular mass in relation to the right sacro-iliac articulation. There are sharp bony spurs about the inner side of the crest of the left ilium, and there is an enlargement and roughening of the symphysis pubis. The lower humeral shafts and the upper half of the radius and ulna are normal, except for some striation about the joints and a small spur on the humerus and head of the radius. The lower end of the right ulna is distorted slightly, and there is a blunt spur on its inner anterior aspect. The lower end of the radii are somewhat broadened. There is a slight relative shortening of the ulna on the right. The knees are negative except for tiny spurs on the phalanges and for mushroom enlargement of the head of the first left metacarpal. The necks of the femora are thickened and the trochanters are irregular and massive, and there is a considerable osteoma on the inferior aspect of the neck of the right femur. About the knee joint the tibiae and femora are

squared and show striation. On the left there is a sharp spur running upward from the inner condyle and a pediculated osteochondroma running upward from the outer condyle. Running downward from the inner condyle of the left tibia is a large chondromatous mass. The head of the left fibula is enlarged and vacuolated and is apparently in firm bony union with the tibia, and the same is true of the right. There is a considerable knock-knee. Faint suggestion of the epiphyseal line in the upper end of the tibia persists. At the ankles the fibulae are relatively short and throw the feet into valgus. There is slight irregular thickening of the lower ends of both tibiae and fibulae, with apparent synostosis.

The deformities in this case consist in a disproportionate shortness of stature, osteochondromas of cervical spines and knee, shortening of forearm with ulnar deviation of wrist, short fingers, considerable knock-knee, mild pes valgus, synostosis of tibia and fibula, and bony growths on the vertebrae and about the joints, including the sacro-iliac.

The roentgenograms were taken at the Massachusetts General Hospital.

CASE 11.—*History.*—L. C. M., boy, aged 3, white, visited the orthopedic outpatient department of the Children's Hospital, Aug. 29, 1905. He is of Anglo-American ancestry. The father, mother, sister and brother are well. The trouble has persisted since birth. The first symptoms noticed were curvature of the spine and pain in the legs.

*Physical Examination.*—He is well developed and well nourished, and of good mentality. The head is large, the chest prominent above and depressed below. There is a considerable lower dorsal kyphosis, lateral curvature, convex to the left, with rotation. The epiphyses are markedly enlarged at the ankles, knees, elbows and wrists. The legs are short in comparison with the body length and the tibiae show outward bowing.

The diagnosis of multiple cartilaginous exostoses was made. He did not return for further observation.

The boy has grown to the present age of 14, but as he lives at some distance I have not been able to make a recent physical examination, or to get roentgenograms. His mother communicates, however, that this condition has not changed to any great extent during these years. He is sensitive about himself, but goes to school. He has a considerable stoop in walking; except for this deformity and the bony tumors he is well.

CASE 12.—Miss G., a young woman of Anglo-American ancestry, born in New Hampshire, nurse, presents certain well defined characteristics of the disease, namely, shortness of stature, juxta-epiphyseal hyperostoses, and multiple bony growths. She is sensitive to her condition, and will not consent to an examination or roentgenoscopy. The case is included for statistical purposes only.

## GENERAL OBSERVATIONS

I have found in the American literature fourteen articles on this disease and four recorded case reports, the earliest dated 1875. The inevitable deduction seems to be that the condition is a rare one in this country. The cases formally reported in these records number twenty-nine; but if the cases mentioned in discussion are added, as well as the relatives stated as being affected, the total is brought up to seventy-one. Some of these, however, were not residents of the United States.

But in comparison with these figures I can say that in a period of about a year in Boston I have unearthed the series of twelve cases herewith presented, and a few months ago Ashhurst reported a series of thirteen cases from Philadelphia. Accordingly, it is easy to believe that with more widespread knowledge of the condition, an interested search will bring to light many cases in other communities, and raise the disease out of the ranks of uninteresting rarities.

As to the sex occurrence, adding my cases to the seventy-one mentioned above, there are seventy-three in which the sex is given. Of these fifty-five are male and eighteen female, just about in the proportion of 3:1. This agrees with the figures which I stated in my previous article.

The question of nationality is interesting, but it is a complicated one to work out in this country, where so many racial stocks are involved. Many authors make no statement whatsoever on this point. Dr. Percy's family of twenty-six patients were of Dutch birth or descent; five others are given as being of German birth or descent, and there were two of Irish, and one each of Italian, Austrian, English, and French-Canadian birth or race. One had an English father and French-Canadian mother. The Austrian was a Jewess, and is one of the very few reported. The negress reported by Dr. Ashhurst is the only one

I have found in the literature, although the disease is known to affect others than Caucasians. Of the remaining forty-five, some are stated as being native-born of Anglo-American stock, and the rest were probably for the most part of the same origin. I previously stated that the German cases predominated in the literature (60 per cent.); next followed the French (27 per cent.) and English (8 per cent.). All other countries together showed only 5 per cent. This American series is interesting for the predominance of Anglo-Americans, and the occurrence in a negress and a Jewess.

Heredity has been a hard matter to study in connection with the disease, because the country is young and the population mixed and to a large degree migratory. Many of the case reports have been casual, and make no mention of this subject. It happens that we now have several families authoritatively worked out in this country. The largest is that of Percy, with twenty-six affected in four generations; then comes Gibney's with four in two generations, mine with three in two generations, Boggs with father and son, and Ashhurst with two, and probably three, brothers. In addition there have been reported in discussion a girl with two brothers and probable father (Taylor); a brother and sister, with mother, grandmother, and great-grandmother (Ashley), and three generations (Freiburg). Accepting these, we may say that inheritance or familial occurrence was shown in fifty cases. In the remaining thirty-two, it is stated in twelve that no evidence of heredity was obtained.

The characteristics of the disease in the cases here reported have agreed well with my previous description of the disease. The affection is distinctly one of the period of skeletal growth. It has been usually first noticed in infancy or early childhood; the manifestations have increased with skeletal growth, and ceased at skeletal maturity. Chondromatous tumors may increase rapidly in size, and regress, either before

or after maturity; but the bony spurs, usually capped with cartilage, grow slowly and are undoubtedly fixed at skeletal maturity. They may fracture, and the fractured portion absorb, or the bursa which frequently covers them may become inflamed from irritation, and form an abscess or subside, or a spur may become infected and carious. It is unlikely that the bony elements regress in adults, although Davis records a case in which this apparently occurred under his observation in a man of 53.

Disproportionate shortness of stature was constant in the seven of my cases in which it was measured for, and Ashhurst reports it as a finding in one case. I believe that it will be found practically constant in well marked examples of the disease. Generally, the cases have shown irregular juxta-epiphyseal hyperostoses, particularly marked at knee, hip, shoulder, ankle and wrist. The lower end of the femur and the upper end of the tibia have shown a characteristic squaring-off, with spurs at the corners, running upward from the femur, and downward from the tibia. These spurs should not be confused with the developmental exostoses about the knee, which are similar, but are purely local, and bear no definite relationship to this disease. These spurs may increase in size and change their shape in the period of growth. The enlargements at the metaphyseal ends increase in length with skeletal growth; in the younger patients they are thin in density, and striated or mottled in appearance; the older cases are striated longitudinally, and are dense in structure, with heavy more or less wavy outline.

The lower end of the ulna, occasionally of the radius, and both ends of the fibula characteristically show a thin bubble-like vacuolation, suggesting cysts. The bone becomes denser and the outline more regular in the older patients. In the majority of cases the ulna and fibula are disproportionately short in relation to the radius or tibia. The ulna is likely to end in a point,

articulating with the radius on its mesial aspect, but not partaking in the carpal articulation. This gives rise to a club hand, or a weak wrist with ulnar deviation (potential manu vara). The relatively excessive length of the radius is also taken up in a bowing of the shaft, sometimes with a dislocation upward of its head, and rarely in a spiral twist about the ulna (case of Carman and Fisher). The relative shortening of the fibula disturbs the mortise at the ankle joint, and causes a structural valgus. The tibia is a strong bone, with its ends firmly set into joints, and it does not become distorted from the shortness of its companion, as does the radius. The fibula frequently becomes structurally united with the tibia at one or both extremities; sometimes, instead, there is a long irregular pseudarthrosis, particularly at the lower end.

The fingers and toes show the same type of bulbous juxta-epiphyseal enlargement, vacuolated in the younger patients, becoming denser and more regular in outline later. In marked cases these form double knuckles, and prevent complete closure of the fist. Frequently fingers or toes are irregular as to length, one being longer or shorter than it should proportionately be. There seems to be demonstrable correspondence between the amount of bony involvement and the extent of retardation in growth. Generally, the hands are small and chubby. Fingers may be crooked or a phalanx subluxed, from an irregular growth.

The cranium is generally not involved, although in one case a spur on the left superior curved line of the occiput is cited (Ochsner and Rothstein). There may be growths on the jaw, or the mastoids and other prominences may be roughened and enlarged. One case in this series was diagnosed as exostosis in the sella turcica, and Virchow found at necropsy that the occurrence of small spurs on the basilar process at the spheno-occipital junction was common. The spine frequently shows a lateral curve, and occasionally spurs on the bodies or spinous process are demon-

strable by roentgenoscopy. Clavicles and scapulae frequently show spurs, thickening, or irregularities in outline, which, if subcutaneous, may cause ulceration of the skin. The ribs often show enlargement at the costochondral junction (rosary), occasionally a spur, or a broadening of and synostosis between ribs. There may be irregularities about the head and neck of the ribs, and occasionally the thorax shows a marked caving in of both sides.

Growths at the lumbosacral junction and about the sacro-iliac joint are frequently demonstrable. The pelvic bones are likely to be thickened, lessening the diameter of the superior strait; the crest may show striation, or there may be spurs on or within the crest. The upper end of the femur is enlarged and irregular, and the neck is short and thick. This may rarely interfere with function. Knockknee in mild degree is common, and in excessive degree not unusual.

Pediculated osteochondroma may arise from any affected portion of the skeleton, particularly from the juxta-epiphyseal hyperostoses. They may grow rapidly in size, even after the cessation of skeletal growth. The shafts of the long bones are likely to be free from irregularities or spurs, these grouping themselves at the metaphyseal ends. It may be said categorically that the bony irregularities mark the progress of a disturbed or pathologic ossification at the epiphyseal line. The epiphyses of the bones most affected usually show some distortion in the roentgenogram, and at the wrist this may be very marked. The union of epiphysis with shaft is abnormally early, as a rule.

The skeletal disturbances and malformations are generally speaking symmetrical for the two sides of the body. Usually minor differences may be apparent, in degree of distortion, but it is rare to have any one side suffer a great deal and the other be only slightly affected. This occurred, however, in one case, that described by Coon. This patient resembles those of the small series discussed by Ollier, Wittek and Fran-

genheim, and in several other ways he departs from the rule. I consider this case, however, to come within my definition of the disease.

This series has brought out several cases representing the rarer complications of the affection. Freiburg, in the discussion of Davis' paper, reported a case of popliteal aneurysm caused by friction of a bony spur against the artery. There are only seven other cases of this sort on record.

Nerve complications have been unusually frequent. These include a case with syringomyelia and acromegalic symptoms, probably from a spur in the sella turcica (Oberndorf); cord symptoms from a pediculated intraspinal osteoma (Ochsner and Rothstein) and from a growth at the lumbosacral junction (Harris); both operated on; and peripheral manifestations, (1) in the ulnar nerve from pressure by a bony mass in the neck, and (2) in the sciatic from pressure of an exostosis (Ashhurst). The case of Boggs' had degeneration of the acoustic and optic nerves, muscular dystrophy and thyroid atrophy.

There have been in this series no cases of secondary malignant chondroma. In my previous paper I stated that this occurred in about 5 per cent. of the reported cases.

#### CONCLUSIONS

Hereditary deforming chondrodysplasia can no longer be considered a rare affection in this country. The disease is a distinct clinical entity, whose manifestations are now well defined. The work which has been done on its pathology points definitely to a disturbance in the bone-forming cartilage as the underlying cause. The hereditary nature of the disorder, which has been pretty well demonstrated, gives it an individuality which makes investigation interesting. The disease should be given wider recognition and study, not only for its importance, but also because it opens up the whole field of obscure congenital skeletal affections.

## ABSTRACT OF DISCUSSION

DR. ALBERT H. FREIBERG, Cincinnati: No one can discuss this subject to any great extent because so little is known of the true nature of this condition. I can simply tell you the circumstances under which I saw a case very early in my surgical career, when, as assistant to a general surgeon, we operated on a popliteal aneurysm which was produced by fracture of the pedicle of one of these exostoses in the popliteal space. The case was similar in all respects to the cases Dr. Ehrenfried has shown us; and there was a very distinct history of transmission through the male side of the family for a number of generations.

DR. ALBERT EHRENFRIED, Boston: This disease is not a rarity. I have found seventy-one cases recorded in this country, most of them in the past few years. Ashhurst has just reported thirteen cases from Philadelphia, and the twelve in my series were collected in Boston in less than eighteen months. So it cannot be very uncommon. The disease is a distinct clinical entity. Exostoses play a very small rôle; they were considered characteristic in the days when we had to depend on palpation for diagnosis, but now the Roentgen ray shows the whole bony picture. The pathology of the affection has been cleared up to a considerable degree. My own work has demonstrated a dysplasia of the intermediary cartilage as a basic element in the disease and the chief source of the skeletal deformities, and has corroborated the persistence of islands of cartilage, as the probable source of the hyperostoses and osteochondromas. The matter of heredity I have just touched on. It is a fascinating subject, and when thoroughly worked out will undoubtedly assist us to a proper understanding of the whole group of congenital skeletal affections of which we now know so little.

## COMPRESSION PARALYSIS OF POTT'S DISEASE IN ADULTS

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CHICAGO

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In reviewing my own experience relative to compression paralysis of Pott's disease in adults, I have been impressed by the frequency of its occurrence, of the severity of the symptoms, and the mortality. The general picture of Pott's paraplegia in adults, compared with that usually seen in children, justifies a discussion of the problem which is distinctive in many regards. To approach this subject it is necessary to quote data not only obtained from the records of my own service, but also from other services at Cook County Hospital.

In seventy-five cases of adult Pott's disease, examined and treated at this hospital from January, 1914, to May, 1916, between the ages of 19 and 62 years, paraplegia occurred in twenty-four cases, and of these the known number of deaths was sixteen. The termination in the remaining eight cases is unknown. Surgical procedure, such as osteoplasty or laminectomy, was performed in thirteen of the twenty-four cases at some period in the course of Pott's disease. Postmortems were held in seven cases, of which five had compression paralysis.

Unfortunately a full analysis of my series of cases of Pott's disease is impossible on account of the incomplete records of the cases; nevertheless, they warrant a definite opinion that pressure paralysis of

the cord is relatively frequent in adults. That this complication of Pott's disease should be of frequent occurrence ought not to be surprising, considering the immediate proximity of the cord to the site of the disease.

There are two factors to be considered in compression of the spinal cord in tuberculous spine disease: first, pressure from tuberculous granulation tissue which occurs mostly in children, and second, pressure from intraspinal abscess, usually seen in adults. Though other factors have been prominently mentioned, such as alteration in the position of the vertebrae, producing an angled projection of the spinous process, and protruding sequestra at the site of the kyphos as a sequence of vertebral destruction, they should not be seriously considered. As to the angled projection, the caliber of the spinal cord is not narrowed in the anterior-posterior direction, as is generally supposed, and sequestra are improbable.

In adults, compression of the spinal cord and nerve roots is most frequently the result of intraspinal abscess, although occasionally due entirely to granulation tissue. It is not exceeding the limit of probability to state not only that intraspinal abscess leads to paralysis, but also that the pressure will usually be protracted and tend to produce severe injury to the cord. Eventually the abscess may make its way out of the spinal canal into the deep tissues, though without corresponding relief of the symptoms. In exceptional cases, however, the paralytic symptoms may disappear if the pressure has existed only for a short time and has been relieved by the migration of the abscess outside of the vertebral canal.

Intraspinal abscesses are interpreted in roentgenograms as irregular, dark, wavy shadows surrounding apparently destroyed vertebrae. On the roentgenograms of patients with tuberculous spines, available for examination, intraspinal abscesses were observed

in eighteen. Of this number fifteen had clinical symptoms of compression paralysis; whether or not the other three cases developed paralysis is unknown. In two paralytic patients with no characteristic symptoms of tuberculous spine disease and in which the roentgenograms did not show either vertebral bone destruction or shadows indicating abscess formation, the diagnosis of Pott's disease with intraspinal abscess was made only after postmortem examination. Five paraplegic patients went to postmortem, and intraspinal abscesses were found in all.

In children the majority of cases of Pott's paraplegia are due to pressure from inflammatory changes in the dura mater, the result of extension of the tuberculous process into the vertebral canal. This produces a disturbance of function without setting up a destructive or degenerative process. Only occasionally does an intraspinal abscess occur. These observations are based on (1) the examination of roentgenograms of tuberculous spines in children, which seldom show shadows indicating intraspinal abscesses, and (2) the fact that children afflicted with Pott's paraplegia when treated by recumbency on a Bradford frame, with or without traction, generally recover.

That recumbency can influence ultimate recovery in Pott's paraplegia where there has been severe and protracted pressure with consequent injury to the cord is improbable. In my opinion, restoration of function following recumbency ensues only when the stress has been moderate, as from tuberculous granulation tissue. Therefore, when recovery follows compression paralysis of Pott's disease, either in children or in adults, the lesion must generally be considered as having been a tuberculous granulation tissue rather than an intraspinal abscess. Of the twenty-four patients afflicted with Pott's paraplegia, due to intraspinal abscess, not one complete recovery has been recorded; generally death has resulted; but in those cases which,

perchance, have not proved fatal, the degenerative changes in the cord were so great that a permanent paralysis remains. However, one patient (Case 3) partially recovered.

The treatment of so persistent an affection as Pott's paraplegia, the result of intraspinal abscess, has been without favorable effect. In the routine treatment of Pott's disease, I have operated both by the method of Albee and Hibbs, but neither has made any noticeable impression on the paralysis. Laminectomy, too, has been tried without securing results. In fact, where laminectomy was performed on four patients, death followed within a short period.

Postmortem examination in the five patients previously mentioned revealed total destruction of one or more vertebrae with abscess formation. The abscess communicated through the space formerly occupied by the destroyed bodies of the vertebrae, compressing the spinal cord. The dura mater was enormously thickened, markedly infiltrated and covered by yellowish, caseous material and occasionally by soft granulation tissue masses; the inner surface was smooth. The spinal cord was hyperemic in the region of the compression, and was completely severed in three cases. In one case it was compressed from side to side. Pulmonary tuberculosis was the primary cause of death in four cases.

The following cases are selected to substantiate my observations of compression paralysis of Pott's disease, and also to introduce phases of the subject not hitherto discussed in the text of this paper:

#### REPORT OF CASES

CASE 1.—W. C., man, aged 56 years, admitted to the medical service of Cook County Hospital, June 24, 1914, complained chiefly of pain in the left side of the chest for the past two weeks, and during this time cough developed which gradually grew worse.

The lungs gave a distinct friction rub in the left side, and a few râles could be heard. Tubercl bacilli were found in great numbers; reflexes were normal.

Aug. 7, 1914, the patient complained of a beginning weakness in the legs. Three weeks later he could not walk without support. At this time he had a steppage gait, exaggerated knee jerks and ankle clonus on the left side. No deformity of the spine nor typical symptoms of Pott's disease were present. Roentgenograms showed destructive lesion of the third, fourth and fifth dorsal vertebrae and a shadow denoting abscess formation.

Sept. 14, 1914, he complained of pain in both legs. The knee jerks were markedly exaggerated; Babinski was present and there was incontinence of urine, etc. He was transferred to the orthopedic department, and from there referred back to the ward for pulmonary tuberculosis, because he was not considered an orthopedic case.

He died, Oct. 11, 1914, and a necropsy showed caseous tuberculosis of the tracheobronchial lymph nodes; apical pulmonary tuberculosis; necrosis of the fifth and sixth dorsal vertebrae and a tuberculous abscess communicating through these vertebrae, pressing on the dura mater. Microscopic examination of the spinal cord was not made.

CASE 2.—H. H., man, aged 22, entered the neurologic department of Cook County Hospital, Jan. 18, 1915, complaining of pain, numbness, heaviness and stiffness in both lower extremities, and also difficulty in walking. Seven years previous he had tuberculosis of the cervical region of the spine, but he has been without any discomfort up to one year ago, when the foregoing symptoms appeared.

Muscle power is good in the upper extremities, but decreased in the lower; both lower extremities are spastic, the right more than the left; tendon reflexes markedly exaggerated; Babinski is present and ankle clonus increased. There is a small kyphos in the region of the eleventh dorsal vertebra.

Roentgenograms show bone destruction of the lower dorsal and first lumbar vertebrae, but no apparent shadow indicating abscess formation.

The diagnosis is compression myelitis of Pott's disease.

Feb. 20, 1916, laminectomy was performed, and the patient died about two weeks later. No postmortem was held.

CASE 3.—M. S., man, aged 20, admitted to my service at Cook County Hospital, May 31, 1915, as a transfer from the tuberculosis ward, stated that he had been coughing more or less for about one year. Six months ago he became aware of a small deformity in the dorsal region of the spine which had increased in size. He suffered no particular discomfort other than the inability to bend the spine freely. In the past four months he noticed a gradual difficulty in walking—a sense of heaviness and stiffness in the legs.

The gait is slow, with a stiffness and dragging of the feet; tendon reflexes are exaggerated; there is loss of muscular

power, and loss of cremasteric and abdominal reflexes; Babinski is present and ankle clonus increased. There is a small kyphos at about the seventh to the ninth dorsal vertebrae, and impaired resonance of the left upper lobe and the right lower lobe, together with a few subcrepitant râles.

Roentgenograms show collapsed bodies of the eighth and ninth dorsal vertebrae and a very classical shadow around the seventh to the tenth dorsal vertebrae indicating cold abscess.

The diagnosis is tuberculous spine with beginning paraplegia and incipient pulmonary tuberculosis.

June 15, 1915, the Albee operation was performed.

Dec. 1, 1916, the condition on discharge to Oak Forest Infirmary was about the same as mentioned above.

June 6, 1916, the patient returned to Cook County Hospital for examination. He walked with a quick, firm step; the tendon reflexes were markedly exaggerated; Babinski was present and ankle clonus increased.

Roentgenograms showed a shadow surrounding the seventh to the tenth dorsal vertebrae indicating a cold abscess.

CASE 4.—M. M., woman, aged 31 years, admitted to Cook County Hospital, April 23, 1915, complained of parasthesia in legs and feet; she was unable to use the lower extremities, and also there was incontinence of urine and feces. The paraplegia began eight months before with sensation of tingling, numbness and a "dead feeling" which steadily increased. Previous to this time she had been well.

There was complete paralysis in the lower limbs, spastic in type. All reflexes were exaggerated and Babinski positive on both sides. Sensory disturbances were limited to the lower half of the body up to the region of the umbilicus, running in a circular line around the body; there was kyphos in the region of the third and fourth vertebrae. Bladder and rectal disturbances were marked. There were trophic sacral bedsores.

Roentgenograms showed marked bone degeneration involving the fourth to the twelfth dorsal vertebrae and also a very definite shadow opposite the fourth to the eighth dorsal vertebrae, indicating cold abscess.

The diagnosis was tuberculous spine disease with paraplegia.

Patient died, May 22, 1915, and necropsy revealed a cold abscess the size of the fist in the region of the third to the fifth dorsal vertebrae projecting anteriorly into the chest cavity. The sac of the abscess was thick and on opening a cheesy, yellow tuberculous pus exuded. The bodies of the third, fourth, fifth and sixth vertebrae were destroyed, through which the abscess sac compressed the spinal cord to the extent of almost complete severance. The dura mater was markedly infiltrated—a peripachy meningitis—in the region opposite the lower part of the cord and cauda equina. The

spinal cord was curved on itself in the upper dorsal region. Microscopically the gray matter was broken up in separate patches irregularly scattered over the surface, so-called heterotopic changes, which are considered to be artificial. Above and below the focus of softening there were found ascending and descending degeneration. In the posterior and lateral columns were circumscribed foci of softening surrounded by some glia tissue.

CASE 5.—E. K., man, aged 22, entered the neurologic service of Cook County Hospital, June 15, 1915, with the following history: About two weeks previous he became aware of a difficulty in getting out of bed; for the next three or four days he could manage to get up and around to a slight extent, but if he tried to move fast he would fall. At the present time he is unable to walk and has slight pains in the shoulder and back. Otherwise the history is negative.

In the left supraclavicular space and just in front of the right trapezius muscle, apparently connected with it, is a soft, painless, freely movable tumor about the size of a small hen's egg; patient states that this tumor appeared about five days previous to his inability to walk. On the left pectoralis major muscle, near its origin, is a soft, distinct, painless tumor extending from the second to the fifth rib the size of a man's palm, which has been present for about two months. No fluctuation is obtainable. Below this tumor is a small, painless, fluctuating one about  $1\frac{1}{2}$  inches in diameter from which a brownish, yellowish fluid was aspirated. The tendon reflexes are exaggerated; Babinski, Gordon and Oppenheim are present. Anesthesia is complete in the lower limbs up to the level of the eleventh dorsal vertebra; from the seventh to the eleventh dorsal vertebrae there is hypesthesia; pain, heat and cold touch are lost in this region; there is apparent lack of control of the sphincter muscles. There is deformity of the spine.

The luetin test proved negative. The Wassermann blood test was positive, while the Wassermann spinal fluid test, made ten days later, proved negative. Roentgenograms showed no destructive changes in the vertebrae nor a shadow indicating abscess formation.

The diagnosis of myelitis (traumatic or compression) was made.

The patient finally died, Dec. 3, 1915. Necropsy showed miliary tuberculosis of both lungs; fibrocaseous tuberculosis of the tracheobronchial lymph glands, and fatty degeneration and passive hyperemia of the liver. A tuberculous abscess, about 4 cm. in diameter, was bulging from the fifth and sixth dorsal vertebrae, the bodies of which were completely destroyed. On opening the vertebral canal there was a tuberculous, cheesy mass surrounding the dura mater opposite the fifth and sixth dorsal vertebrae. The dura mater over the

dorsal and lumbar region was found enormously thickened and covered with caseous and soft granulation tissue masses. On opening the dura mater, the inner surface was smooth, but hyperemic; the cord too was hyperemic. Microscopically the lower cervical region of the cord showed a patch of softening occupying the posterior horns and part of the posterior columns. The axons were found swollen and broken up in small fragments, while the hyalin was in the form of lumps, drops or droplets. The glia showed the so-called ameboid transformation. In addition there were present the usual findings of ascending and descending degeneration.

CASE 6.—M. O., woman, aged 25 years, entered my service at Cook County Hospital, July 3, 1915, as a transfer from the neurologic service. Six months before she complained of pain in the abdomen followed by numbness and tingling in both legs. One month later she lost complete power in the lower limbs. About two months afterward an operation (laminectomy) was performed.

Both legs lie extended and immobile; patellar reflexes, ankle clonus and Babinski are absent. There is a scar over the region of the middle and dorsal vertebrae as from recent operation. There is no apparent kyphos. Sitting up increases the pain referred to the abdomen. There is incontinence of urine; there are trophic ulcers over the sacrum and some dry râles over the right chest anteriorly.

Roentgenograms show destruction of the tenth and eleventh dorsal vertebrae, and also a very definite shadow in the region of the seventh to the eleventh dorsal vertebrae indicating cold abscess.

The Wassermann test was negative.

The diagnosis was tuberculosis of the spine with paraplegia and pulmonary tuberculosis.

Necropsy revealed a cold abscess about the size of a lemon along the ventral aspect of the dorsal vertebrae and communicating through the space formerly occupied by the bodies of the tenth, eleventh and twelfth vertebrae, which were completely destroyed. The anterior and lateral portion of the seventh and eighth dorsal vertebrae were roughened. The dura mater was thickened and covered by cheesy material; the inner surface was smooth. The spinal cord was seen to be entirely severed at this level. There were fibrocaseous ulcerative tuberculosis of the lungs; fatty degeneration of the liver and kidneys; trophic ulcers, etc.

CASE 7.—M. T., woman, aged 25, entered my service at the Cook County Hospital, July 26, 1915, with a history of tuberculous spine disease of two years' duration for which she had been treated. About three weeks previous to her entrance to the hospital, her legs became weak and finally she was unable to move them. She also suffered from incontinence of urine.

There are typical symptoms of compression myelitis, and a kyphos in the upper as well as in the lower dorsal region of the spine. Roentgenograms show apparent necrosis of the bodies of the fourth, fifth, sixth, seventh and twelfth dorsal and first lumbar vertebrae, and also a shadow in the region of the middle to the lower dorsal vertebrae, denoting abscess formation.

The diagnosis is tuberculous spine disease with paraplegia.

Dec. 15, 1915, necropsy revealed a focus of encapsulated, fibrous, caseous tuberculosis in the apex of the right upper lobe of the lung; bilateral fibrous adhesive pleuritis; marked bilateral disseminated bronchopneumonia; between the third and fourth dorsal vertebrae, there was a possible partial dislocation of the spine; that is, there was a necrosis of the bodies of the second, third and fourth dorsal vertebrae, and between the third and fourth, this necrosis was so marked that the normal intervertebral attachments were loosened to permit of marked abnormal mobility. The bodies of these bones were, so to speak, collapsed on each other. In opening the ileopsoas group of muscles on either side, there was a large quantity of yellowish, cottage cheese-like material which had excavated a cavity in these muscles approximately 4 by 18 cm. There were sinuses leading from the upper end of these cold abscess cavities to the region of the twelfth dorsal and the first lumbar vertebrae. The bodies of the seventh, eighth, ninth, tenth, eleventh and twelfth and the first lumbar were necrosed, of softened consistency, and yellow. Between the twelfth dorsal and the first lumbar there was so much necrosis that here, too, the bodies had collapsed to make the angular deformity described in the lumbodorsal region. On removal of the spinal cord there was a marked narrowing of the spinal canal in the upper dorsal region adjacent to the third and fourth dorsal vertebrae. This narrowing was so marked as to have caused a definite marked narrowing of the adjacent spinal cord. The dura mater in this region was greatly thickened, and on its exterior surface had a granular appearance and yellow color as that found in the adjacent bone. In the lumbodorsal region, there was no narrowing in the spinal canal. The dura mater at this point, however, was greatly thickened, and there was some dependent edema of the leptomeninges. There were no adhesions between the leptomeninges and the dura mater in any part of the cord. The lumbodorsal bone necrosis was at the level of and below the beginning of the cauda. Between the dura and the bodies of the lower dorsal vertebrae, there was an infiltration of cheesy material. This infiltration is an extension from the necrosed dorsal and first lumbar vertebrae. The deformity in the upper dorsal region has been produced by a slight collapse of the bodies of the third and fourth vertebrae; the deformity not being great, the collapse is not great. The necrosis of the arches of these

vertebrae is so great that the narrowing of the spinal canal is in the lateral rather than in the anteroposterior diameter. This encroachment on the lumen of the spinal canal is due to an infiltration of the dura with caseous material and the consequent fibrous infiltration of that membrane.

Microscopically the spinal cord gave the typical picture of so called diffused myelitis, that is, the cord had the Swiss cheese appearance, numerous vacuoles, swollen axons, broken up myelin and the so-called ameboid transformation of glia. The vessels showed marked infiltration of the adventitial lymphatic spaces. In addition there were present signs of secondary degeneration.

#### SUMMARY

Compression myelitis may be the first clinical signs of an unsuspected Pott's disease, often unmasked by roentgenograms. The severity of the compression is correspondingly shown by the intensity of the clinical phenomena.

Intraspinal abscess is the dominant factor in subjecting the spinal cord to pressure, borne out by laboratory examinations and postmortem findings. At first the pressure may not make any appreciable alteration in the nerve element, but sooner or later there is severe damage to the cord resulting in primary and secondary degeneration; in time actual necrosis and severing of the cord may occur as already recorded. It therefore follows that the paraplegia will be complete and permanent, though occasionally it may be but partial: As a rule, death may be anticipated — generally from pulmonary tuberculosis. It cannot be denied, however, that complete recovery may take place even after the paralysis has existed for a long period of time. But in this connection a second factor must be considered in the mechanism of compression, namely, tuberculous granulation tissue most commonly occurring in children, which invades the vertebral canal, and a moderate pressure is manifestly enough to excite functional disturbance without necessarily having an actual mechanical destruction of the nervous elements. This fact is of practical importance, as it explains the cause

of recovery, which occurs by absorption of the tuberculous granulation tissue.

No reliance can be placed on operative procedure. Where laminectomy has afforded relief, it has been due to the accidental evacuation of the abscess; it is a serious operation and the immediate mortality is large.

31 North State Street.

#### ABSTRACT OF DISCUSSION

DR. C. B. FRANCISCO, Kansas City: Formerly we were taught that Pott's paraplegia was, as a rule, the result of bony pressure. It is now generally considered that the pressure is due either to granulation tissue, abscess formation or an extension of the process to the meninges. In children I believe that the pressure is usually the result of granulation tissue, and that recovery is the rule. Occasionally a child will not recover completely. Recently I had a necropsy on a child that had had very efficient treatment for ten years; it had started off with the paralysis early in the disease, and had been continuously paralyzed, walking, at times, with considerable difficulty. In that case, we found a direct extension to the meninges (that is, an infiltration due to extension of the process); but these cases, I believe, are very rare. There is seldom bony pressure in children, if ever. In adults, it has been my observation that a case of tuberculosis of the spine developing paraplegia is going to continue to have signs and symptoms of the paraplegia. Whether the original pressure is due to abscess formation or meningeal involvement, it is maintained sufficiently long to produce destruction of the cord structures and removal of the pressure then does no good, therefore it is useless to do a laminectomy. These cases will continue to have exaggerated reflexes and considerable difficulty. It is rather rare, I believe, to see a case that improves as much as the one Dr. Jacobs reports, in which the patient became able to walk very well, but still had the reflexes exaggerated.

DR. J. T. RUGH, Philadelphia: My experience rather leads me to feel that the prognosis in adults depends very much on the involvements or complications in other parts of the body. If the patient does not have any pulmonary lesion or any active lesion in other parts of the body, the prognosis of the spinal condition is better. A year or so ago, I had a case of paralysis of about a year's standing, in the Philadelphia General Hospital. As a last resort, and because of inability to control the patient as he was, I placed a bone-graft in the spine. Six months later, he met me in the corridor, walking around with a cane. It is now two years since the graft was

inserted, and he is now driving a dray in the city. I have been able to duplicate that result in several other patients with disease of a similar type, in which there was no complication. Those of my patients that have not recovered or have shown no improvement, have usually died of complications, pulmonary, renal, or whatever they might be.

DR. A. L. FISHER, San Francisco: There ought to be a complete neurological examination in all these cases as a routine. For the last year we have been making not only the examination of the motor nerves and reflexes, but also of sensibility, tactile sensation, cold and heat sensations, etc. Although the results are not yet sufficient to draw any conclusions, I have seen some evidence that there are in some instances, disturbances of sensation before any evidence of motor impairment is shown.

DR. REGINALD H. SAYRE, New York: I agree with Dr. Rugh that it is the lesion in some other part of the body that generally proves fatal in these cases, and my personal experience has been that a much larger number recover with good function than would seem to be the history with the patients that most of the other gentlemen have seen. I have under treatment at present three adults who were paralyzed for periods of from six to eighteen months. They had both sphincters paralyzed; and in two cases, there were bedsores. These patients have practically recovered. Two of them are supporting themselves. The other patient has so far recovered as to be able to move around the ward with difficulty; but she has improved so much within the last six months that I think she will make a good recovery ultimately. She was a mass of bedsores when she first came under my observation; and a diagnosis of transverse myelitis had been made, Pott's disease not being suspected. Nothing had been done; but with traction and hyperextension in bed, she began to recover very soon. She has slowly increased in her capability of looking after herself, and is, I believe, on the way to recovery. In most of the fatal cases that I have seen, the pressure was in the cervical region. I have seen several that went to a fatal termination, and there was marked meningitis at the time of death—the cerebral meninges being involved as well as those of the cord.

DR. F. J. GAENSLEN, Milwaukee: I want to report a procedure that I used in two instances in which the paralysis came on suddenly, and in which the condition would probably have terminated fatally otherwise. The first thing I did was a laminectomy, splitting the spines as you would in an Albee operation. The advantages of that are that when you close up the wound, you have a very firm line of union. In addition to the laminectomy, I put in a tibial graft over the laminectomized portion of the spine. In one instance, I removed the laminae of the fourth, fifth and sixth cervical; and in the other three laminae in the dorso-lumbar region.

DR. JAMES T. WATKINS, San Francisco: I want to report progress in a case belonging to the group described by Dr. Jacobs. The patient was a young woman with a complete paraplegia and multiple sinuses pointing in her back low down. In the hope of inducing these abscesses to discharge elsewhere and so enable me to get a clean back to operate on, I had her put on an inclined plane. My hopes were realized. In time she developed sinuses in each groin and those in the back healed up. Shortly afterward I went off service and Dr. Sherman took the case over. He did a laminectomy and removed a large tuberculoma from the neural canal. The outcome to date is most gratifying. It is less than six months since the operation and she already walks with assurance.

DR. EDWARD S. HATCH, New Orleans: I agree with Dr. Rugh that if they do not have other complications, these adult patients do well. I see many adult negroes come to the Charity Hospital with paraplegia or great weakness; and in the cases in which there are no other complications, the prognosis is good. I have one man who was absolutely paralyzed, but who could get around a little in three months and is steadily improving. It is a great mistake to say that we cannot do anything for these patients.

DR. ALBERT H. FREIBERG, Cincinnati: There is very little difference of opinion as to the correctness of the general considerations which Dr. Jacobs has placed before us. At the same time, I question whether we may applaud all that he has said with reference to these cases, whether in child or in adult. The demonstration of an abscess around the spinal column in a roentgenogram in a case of paraplegia does not prove that the abscess stands in direct relation to the paraplegia. Neither is it possible to be quite so definite as to what is going to happen as the result of conservative treatment in child or adult. The proof can not be seen in the roentgenogram, but in the conduct of the case. What is important is that we should first use adequate mechanical means for placing the spine in a properly corrected position and for maintaining an exact immobilization with comfort to the patient and for a sufficient length of time to be able to judge, by the patient's behavior afterward, whether he is improving or not. If he is not, we are not accomplishing what we are after; and then the question of some other kind of intervention comes up. This is as true with reference to the child as to the adult, but the difference between the two classes of cases lies in the fact that improvement is more likely and more rapid in the child than in the adult. For these cases it is my custom to use the Lorenz plaster bed, and not the Bradford frame for immobilization. By this means, I can secure what we call hyperextension, but which it would be better to describe as a corrected position; and, in addition, I hope, a greater degree of immobilization. This appliance is always under control, and enables one to see that the patient

receives proper care of the skin. Our experience has been most gratifying in the treatment of these cases. I may have been more fortunate than most. We are going through this experience with some cases now. The ultimate fact to be looked for is continuous improvement, even though slow. So long as that is going on, I feel that we are moving in the right direction.

DR. C. M. JACOBS, Chicago: I do not deny that some patients get well; but what I have tried to bring out is that when this occurs the pathologic lesion is a tuberculous granulation tissue rather than an intraspinal abscess. We know that most cases of Pott's paraplegia in children get well; on the other hand, my records show that out of 24 adult cases, 16 were known to end fatally. Children with Pott's paraplegia are placed on a Bradford frame, with or without traction, and as already stated they usually get well. The roentgenograms in these cases do not show a shadow indicating abscess. When the roentgenograms show abscess formation there is more or less permanent paralysis. At the Home for Crippled Children, I have two patients with Pott's disease who have been paralyzed for the past two years. I have tried in every way to modify the condition by different methods—particularly with rest, but without success. The roentgenograms show a shadow which I have diagnosed as an intraspinal abscess. According to my observation, Pott's paraplegia in adults, due to intraspinal abscess, is usually followed by complications such as pulmonary tuberculosis, bronchopneumonia or tuberculous meningitis. Dr. Sayre did not state whether roentgenograms were taken of his cases and if so, whether a shadow was shown indicating abscess formation.

DR. SAYRE: In both of my cases I believe that there was an abscess present; because, after the disappearance of the paraplegia, abscesses showed themselves—in one case, in the spine, and in the other, in the groin. These abscesses were opened and washed out, and disappeared.

DR. HIBBS: These were intraspinal abscesses, not ordinary abscesses?

DR. SAYRE: I believe that these abscesses had their origin in the spinal canal, as the result of a process going on in the vertebra and elsewhere in the canal. They exerted enough pressure to cause paraplegia. Then, before they were done, they became extraspinal abscesses; and, with relief of pressure in the canal, the paralysis disappeared. This does not occur in all cases, but did in these.

## A PLEA FOR THE PREVENTION OF DEFORMITIES IN THE HEALING OF BURNS

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We are all familiar with the deformities following the healing of burns and the difficulties attending their subsequent correction. The relief of the bat-wing deformity following burns of the axillary region and the often severe flexion deformities of the joints of the extremities is no pleasant task for the surgeon and the improvement obtained is frequently but a painful compromise. The deformities following burns of the anterior and lateral region of the neck are also quite unpromising.

The burns on the extensor surfaces as a rule cause very little interference with function, as the movements of the unsupported joint are usually best controlled in a position of partial flexion. This keeps the extensor surface long during the healing and flexor efficiency prevents further contraction after healing.

Deep burns may affect the integrity of the structures so severely that recover of function is impossible and even amputation may be necessary. These will be treated according to the indications, the same as equally extensive traumas from other sources; but the burns I especially wish to consider are the usual ones of the so-called third degree, destroying the skin completely in some areas and leaving the deeper structures practically intact and ready to resume their function when the wound is healed.

It is with reference to this class of burns, the usual type, that I recently made the statement that "however

extensive they may be, as long as they are compatible with life, healing may and should be obtained without deformity and with good function."

This refers particularly to burns of the limbs and their connections with the body and does not include burns of the face, although it may well apply to burns of the neck.

If this position can be maintained the surgeon is thus relieved of another serious problem and the patient of much suffering from his permanent physical handicap.

The procedure is simple and aims at the prevention of the deformity by fixing the limb in the most desirable position during the process of healing and for some time thereafter to prevent subsequent contractures. I have been able to do this best with removable plaster casts applied in the early stage of healing, before contractures occur, over the proper dressing of the burn.

The elbow, wrist and fingers should be kept extended. The hip and knee should be extended with the foot at right angles to the axis of the limb, and the toes extended. For burns of the axillary region the arm should be maintained in an abducted position. In burns of the front and sides of the neck the chin must be kept high. The cast can be removed daily, the wounds dressed and the cast immediately replaced during the whole process of healing.

The fixation also directly enhances the healing by preventing injury of new tissue by movements of the limbs. It relieves the flexor muscles of their constant attempts at immobilization to prevent pain and takes away the cause of the pain.

The method as applied combines two features that are mutually helpful. One relates to the dressing of the burn itself, and the other to the application of the cast. The burn, then, is an ulcer and may be treated by skin grafting or such other methods as the surgeon has found successful, provided the limb can be main-

tained throughout the period of treatment in the desired position.

My method in this stage has been the application of ribbons of adhesive plaster directly on the wound and extending some distance beyond the margins for attachment to the normal skin. The ribbons are usually placed at the margin of the burned area first and then laid on in parallel strips slightly overlapping each other until the whole region is covered.

It is usually best to wait until all sloughs have separated before beginning this part of the treatment, as there is no danger of contractures occurring during this early stage. The adhesive plaster is changed two or three times a week or whenever it becomes loosened from the healthy skin. Its removal causes no pain as it does not adhere to the moist surface of the wound, and its application by gentle pressure is equally painless. By its pressure it also prevents exuberant granulations and probably reduces the amount of secretion by its influence on osmosis. Owing to its permeability it furnishes an ideal condition for healing, conserving heat and moisture the same as an unbroken scab, though it is quite impossible to maintain the latter complete over large areas. The absence of mesh also prevents the penetration of the granulations with the subsequent bleeding and pain on their removal. The inclusion of the secretion, that is, the pus, has no more deleterious effect than the same condition existing under a complete scab and is rather to be desired for its moisture than deprecated, as growth can occur only in the presence of moisture, even under the scab. It is much more efficient than the scab over large areas. It is really a wet dressing with the moisture consisting of the patient's own serum plus the ever present bacteria.

Over the adhesive plaster is placed a dressing of dry gauze sufficient to absorb the secretions that make their way out from under the plaster strips at various places. This is usually changed daily, and as it does

not come in contact with the wound, its removal is also painless. Over this is made the circular plaster cast which is afterward opened at convenient places for daily removal for changes of dressing. For the limbs it is usually made bivalve. For the other regions it is cut as ingenuity suggests for its removal and reapplication.

After healing is obtained, night casts closely fitting the parts are made and these are worn for several months, usually at night only, as long as there is a tendency to deformity. Persistent use of the after-treatment is essential to permanent success.

With the proper use of this method the deformities of limbs following this type of burns need no longer occur, and, indeed, their presence must be a reproach to the surgeon responsible for their development.

#### ABSTRACT OF DISCUSSION

DR. J. P. LORD, Omaha: The first function of the orthopedic surgeon is to prevent deformity. Dr. Parker's paper is therefore opportune. Though not strictly new, we are indebted to him for emphasizing this particular method of preventing deformity. His use of plaster of Paris seems desirable. The mere mention of splints in surgical textbooks is not sufficient to bring the matter to the attention of any class of doctors. The time of healing should be conserved by timely early skin-grafting. We should hasten healing even by the early excision of eschars and deep sloughs when indicated. Tissues that have been so deeply burned as to be destroyed should be removed early, to lessen the period of sepsis and hasten the period at which skin-grafting may be resorted to. Such tissue should be excised, and its place covered with a skin-graft or a skin-flap. Otherwise contractures will be invited. There is going to be a tendency to contraction if a number of weeks or months are consumed in the healing of the wounds, because a large amount of connective tissue is formed, and this has the inherent quality of contraction, weeks or months after healing has taken place. The present tendency in general surgery is to get these wounds covered by skin at the earliest possible date, and it has been my experience that it is best when possible to use whole flaps of skin and subcutaneous fat in the more extreme cases. It is my observation that long periods of healing in these cases are quite unnecessary. The securing of straight members at first is not sufficient

to prevent the deformity that is bound to take place subsequently. Early grafting or plastic repair should be applied to flexures of the limbs to secure a more flexible and pliable condition, and one more free from the dangers of subsequent contraction, than it would be after a number of months of healing by granulation under any method. Another reason for the early covering of these suppurating areas with skin-grafts is to prevent the occurrence of intercurrent diseases, to which they are an easy prey in the patient's weakened condition from prolonged suppuration. I would, therefore, sound a warning against a too thorough application of the methods of Dr. Parker and favor lessening the period of healing by application of the resources of surgery.

**DR. CHARLES M. JACOBS, Chicago:** I should like to bring out, as a point of interest, that this method of applying adhesive strips may be used not only in cases of burns, but also on pressure sores as a result of plaster casts. At the Home for Crippled Children, balsam of Peru dressings for pressure sores have been discarded for zinc adhesive strips. The strips can be changed through windows cut out of the plaster casts.

**DR. EDWIN W. RYERSON, Chicago:** I have seen some of Dr. Parker's work, and consider it better than anything I have seen in the past. Even if skin-grafts be applied, as suggested by Dr. Lord, none the less should we use apparatus of this kind, because skin-grafts often tend to contract, and one may be disappointed in the result after skin-grafting unless such precautions are taken. The method advised by Tubby to relieve this contraction should receive more attention than it apparently has in this country. I have had occasion to use it in a few cases. The results are excellent, and one obtains a pliable scar that does not tend to recontract.

**DR. CHARLES A. PARKER, Chicago:** I have taken up only one phase of the subject. The treatment of the burn is the treatment of the ulcer, and you can treat it as such. If you know how to treat ulcers well, you can take care of burns. You do not need a lot of literature, but plenty of adhesive plaster and some grains of common sense. I am much more proud of the two boys that had the straight legs and never had any contractures than I am of the ones that I had to straighten afterward. The skin-grafting is all right, but I have been taking care of a boy whose burns after four years of skin-grafting, never were healed. Auto-skin-grafting is all right as far as it goes, but when you have a little girl with so much burn that there is not enough skin left on the patient to take grafts from, what are you going to do? The patients do badly in extensive burns with skin grafts. I get that information from the general sur-

geon, because I get his cases to treat afterward. It is proper to use skin-grafting when it can be done, but when you come to heal up a wound like that in this boy and get it cured in fourteen months with a straight leg, it is something worth while.

Removal of the eschar is advised by German surgeons. Unfortunately, people who read German think that everything that comes from Germany is good. That, I think, is one of the objections to being able to read German. In the case of a child burned like that, not one of you would do it. He has a hard struggle to live at all. There may be cases in which it is advisable, but not in very large burns. As to overcoming these contracted scars, it does require several months, any way, depending on what the tendency to contracture is. I have seen the scars quit their tendency to contract after some months, but some go on for much longer. Nevertheless, scars do give up this tendency. They sometimes give up when you wish they would hold. We know now that scars of the esophagus give up. I have seen scars from drinking lye do this. So it is in the scar from the effects of a burn. You get scars, of course; but you get the most rapid healing and the smallest amount of subcutaneous scar tissue possible, with no destruction of skin that you have made one day by see-sawing and stretching it out the next. Hold the fingers out straight while they are healing, and there will be no necessity for skin grafts.

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# THE OPERATIVE TREATMENT OF TUBERCULOSIS OF THE SPINE

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NATHANIEL ALLISON, M.D.  
AND  
HERBERT H. HAGAN, M.D.  
ST. LOUIS

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This report is made in order to give our experience with forty cases of tuberculosis of the spine in which operation has been performed in a manner designed to stiffen their spinal columns by internal splintage. Two methods of operation have been used: the osteoplastic operation, known as the Hibbs operation, and the bone transplant operation, known as the Albee operation.

Of the forty patients operated on, nine had reached adult life before the onset of the disease, and thirty-one were children. The oldest patient was 37 years of age and the youngest 19 months of age. The diagnosis of tuberculosis of the spine was made positive in each case by roentgenographic study, the exact location and extent of the disease being clearly made out, and by clinical tests for tuberculosis, and, wherever possible, by guinea-pig inoculation.

Our first operation was done Oct. 5, 1912. Six patients were operated on in 1913; eleven patients in 1914; fourteen patients in 1915 and nine patients of this group in 1916. Of these forty patients, ten were operated on by the method of Hibbs and thirty by the method of Albee.

We have divided the cases into three groups in order more briefly to present their clinical characteristics.

Group 1: Patients operated on in the early stages of Pott's disease with little or no evidence of deformity and no complications.

Under this head fifteen of our forty cases fall. Without exception, this group of fifteen patients have stood the operation well, have had rapid convalescence, all symptoms have disappeared, and we feel that they represent complete recovery.

Group 2: Patients operated on that presented well marked deformity with persistence of more or less acute symptoms, but no complications.

Under this head nine of our forty patients are collected. Of these nine, eight have made recovery and are about without supports and are in fairly robust health. One patient has shown a return of acute symptoms after three years, and has signs of a developing pressure paralysis.

This patient was operated on after the method of Hibbs and did very well up to three months ago. She is now being treated as one would treat conservatively a case of Pott's disease with paraplegia.

Group 3: Patients operated on in the presence of complications to their more or less acute processes of tuberculosis of the spine.

These complications were: psoas or lumbar abscess, 5 cases; tuberculosis of other joints, 2 cases; pressure paralysis, 5 cases; pregnancy, 1 case; pulmonary tuberculosis, 4 cases.

*Psoas or Lumbar Abscess.*—Of the five cases that presented abscess formation as a complication to the Pott's disease, three were treated conservatively as far as the Pott's disease was concerned, and the abscess was opened, its contents cleaned out, and the wound closed. In these three cases we had primary union of the incision for the cleaning out of the abscess.

The operation on the spine was then undertaken. In one of these cases the abscess refilled and dis-

charged through the line of incision. In the other two cases the abscess did not refill.

These three abscesses were psoas abscesses.

In two of the cases, abscesses occurred after the operation on the spine, and they were treated in a similar manner. In one case we obtained healing, and in the second case the abscess continued to discharge but finally closed.

We are led to believe from this experience that abscess formation is not a contraindication to the operation on the spine.

*Tuberculosis of Other Joints.*—In two of our cases, in addition to having Pott's disease the patients had also tuberculosis of the hip joint. After the subsidence of acute symptoms the spine was operated on, and the hip has been treated conservatively in the ordinary manner. One case has been treated with a jacket spica and the other with a Bradford abduction hip splint. Neither of these patients has shown any retardation in their convalescence since the operation.

*Paraplegia.*—Five of our patients have shown symptoms of spinal pressure evidenced by increased reflexes, ankle clonus, and inability to walk or stand.

One of these patients, a man of 30, had symptoms of Pott's disease for five years with a gradually increasing deformity. About two years ago he noticed a jerking of his legs when bearing heavy weight on his toes; shortly after this his legs became weak, especially the right one, and now the toes drag on the floor when walking, and his gait is very stiff. The physical examination showed a sharp line of hyperesthesia extending across the trunk at the level of the sixth dorsal on the right and the fifth dorsal on the left. Below this there was definite hypalgesia. On this man an Albee operation was done, Sept. 16, 1914. After the operation his area of hypalgesia gradually lessened and entirely disappeared, his ankle clonus, spasticity, and plus reflexes have now disappeared, and he is about without symptoms.

The second patient, 2 years of age, Jan. 27, 1915, showed clonus on both sides, Babinski on both sides, and very active knee jerks, and no voluntary power of the thigh or legs. He was operated on, March 22, 1915, an Albee operation being done from the seventh cervical to the tenth dorsal, being

secured by a tibial graft. April 5, 1915, voluntary power had returned to some extent, in both legs, Babinski was still present, and clonus still present. April 28, the child began running a temperature with no assignable cause. May 19, patient is able to move his legs very well. Babinski has disappeared and also clonus. June 26, after a gradual onset, the child died of tuberculous meningitis. One other child in this group who had complete paraplegia died three weeks after the operation of tuberculous meningitis.

The two remaining cases of this group had only slight involvements, evidenced by ankle clonus, slight spasticity and positive Babinski. These two patients after operation rapidly improved. The signs of spinal pressure disappeared, and they are now about without symptoms.

We have been led to conclude from our experience with paraplegia as a complication in Pott's disease that an operation should immediately be done, as it seems to us to offer the best chance for a speedy recovery from the pressure on the spinal cord.

The two patients in this group who died died of tuberculous meningitis, and we have no explanation to offer for the occurrence of this fatal complication.

*Pregnancy.*—One of our patients, a woman of 19, had just recovered from her first pregnancy when she began to notice the symptoms of Pott's disease.

She had a well marked and rapid destruction of her first lumbar vertebra, and appeared at the hospital with her five months old infant. The infant was weaned and the mother was operated on several weeks later, a perfect result being obtained. She gained weight and was about without symptoms at the end of ten weeks and was discharged to her home. In spite of our advice she returned to the hospital at the end of six months again in a state of pregnancy. This pregnancy was allowed to run full term and a normal infant was born. The mother made a normal recovery, and since then has had no symptoms of activity in her diseased spine. A roentgenogram of her graft illustrates this report. This was taken after her second pregnancy and shows the graft in good position but broken through its middle.

In passing, it has been our experience in the study of these grafts after they have been placed in the spine that some of them show signs of fracture after a more or less indefinite period without causing any evidence of trouble.

*Pulmonary Tuberculosis.*—In our group of forty cases we have had four cases that showed signs of more or less active pulmonary involvement. In spite of this complication we have done the operation, doing it as rapidly as possible, so as to cut down the length of time required for the administration of the anesthetic. It has been our custom in these cases, and we might add in all cases where the physical condition of the patient was below par, to prepare the patient completely for operation and have everything ready to go ahead before the anesthetic is administered. As soon as the patient passes the primary stage of anesthesia, the operation is then started and finished as rapidly as possible. In this way considerable time has been saved. In none of these four cases has there been any evidence of the operation causing increased activity in the pulmonary involvement.

*Complications from the Operative Procedure.*—In three of the forty patients operated on there has been infection at the time of operation of the operative wound.

One of these patients, a man of 27, developed a severe *Staphylococcus aureus* infection on the third day after operation in both the wound on the shin and in the back. After a very serious illness from this infection he gradually recovered and his wounds closed. Two pieces of his graft were discharged; one from the upper end of the wound and one from the lower. Healing finally took place and his result has been an excellent one.

The other two cases were slight infections, one of them involving the lower end of the graft, which was discharged, the other being simply a superficial infection at the site of the skin sutures. The other thirty-seven operated cases healed by primary union.

We have been struck in this series of cases, especially in children, with the immediate improvement in general health and with the rapid convalescence that these patients have made after operation. Almost without exception, the children have gained weight, have become very active when allowed to be up, and

presented a marked contrast to the slow improvement seen in cases treated conservatively.

We discovered, what seems to us, to be a valuable method of holding these cases fixed immediately after operation. It is our custom to reverse the Whitman frame so that it lies concave on the bed, and place the child, face down, on this frame, securely binding it as one would in the reverse position. In this way there is no pressure on the operative wound, and the position of hyperextension is more or less perfectly kept up.

We feel from our experience that it is highly advisable, and, indeed, in certain cases necessary to continue support for at least one year after the time of operation. We are led to this belief by the character of bone regeneration which must take place before the spinal column becomes securely ankylosed, and we feel that the too early removal of supports is likely to result in a return of symptoms and an increase in deformity.

#### SUMMARY

Forty patients were operated on.

Two deaths were due to tuberculous meningitis.

There were three infections at the time of operation without serious consequences.

Fifteen patients completely recovered without deformity or complication, and at the present time are far enough along since their operation to be called absolutely well.

Eight patients have deformity, but with the disease arrested and no active symptoms.

Of the sixteen patients who had complications, three with paraplegia have completely recovered, and two have died.

Of those with pulmonary tuberculosis (four patients) there is evidence of activity of disease at present, but the disease of the spine is not causing symptoms.

Fig. 1.—Roentgenogram of bone graft taken one year after operation, showing fracture of graft at seat of disease.

Fig. 2.—Lessening of deformity after Albee operation.

Fig. 3—Lessening of deformity and rapid improvement in general condition after Albee operation.

Fig. 4—Ability to flex the spine one year after Albee operation.

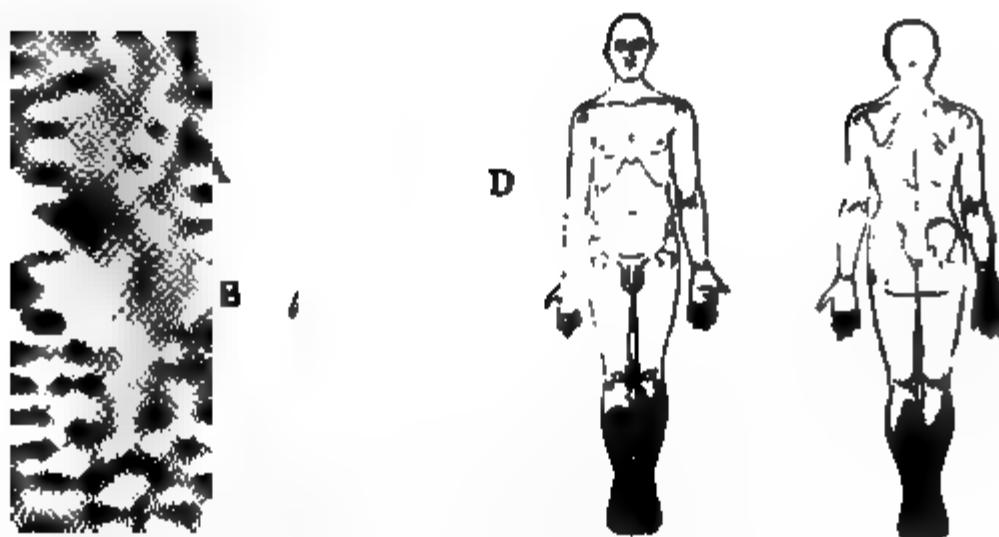


Fig. 5.—Rapid improvement in sensory changes in a case of paraplegia after Albee operation; three weeks' time; patient made complete recovery: shaded area, hypalgesia; *A*, narrow zone to hyperalgesia; *B*, area of normal to increased response to pin prick; *C*, hyperalgetic zone; *D*, gibbous.

Fig. 6.—Reversed Whitman frame used for fixation after operation.

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Of the patients with tuberculosis of other joints (two) these are still under treatment, but are making slower recoveries.

Of the patients with psoas abscess (five) all five have recovered and the abscesses have ceased to discharge.

The total of this group would be four cases of pulmonary tuberculosis, and two of tuberculosis of other joints, making six still under observation, leaving ten in which the disease has been arrested.

We are led to believe from this experience with forty cases that an operation for ankylosing the spine should be performed in every case of Pott's disease as early as a diagnosis can be accurately made, and that the presence of complications should not influence the surgeon in delaying the operative procedure, unless the complications are of too grave a nature.

We do not feel in a position to discuss the relative merits of the Albee operation and the Hibbs operation. We have had equally good results with each procedure. We feel, however, that the Albee operation is more simply done and that on this account it is advisable in the majority of instances.

Our experience with adults and children has been about the same. We feel, however, that the good results obtained are much more conclusive in the case of adults who respond very slowly to conservative measures.

537 North Grand Avenue—600 South Kingshighway.

### **ABSTRACT OF DISCUSSION**

**ON PAPERS OF DRs. ALLISON AND HAGAN**

**DR. J. T. RUH, Philadelphia:** I want to endorse all that Dr. Allison said regarding the after-treatment of these cases. He has shown clearly the unwisdom of leaving off the support too early in these cases, especially in young children. Support must be maintained until bony union takes place, which requires six months to a year or a year and a half. I have done one of these cases by the Albee method, a case of tuberculosis of the atlas and axis. The child was struck on

the side of the neck with a baseball bat. About four hours later he dropped in the street paralyzed. It was thought that the paralysis had come from the injury, but the subsequent history showed that he evidently had a tubercular lesion there and that this accident had simply precipitated the entire trouble. He remained paralyzed for four or five weeks, when an abscess ruptured on the side of his neck and discharged, after which the paralysis cleared up. He came under my care a year and a half after the onset of the tuberculous trouble, with slight spasticity in the lower extremities. I dug a hole in the occiput, and measured my graft to fit between it and in contact with the third and fourth cervical spines. I placed the end of the graft in the lower pocket, tilted the head forward, and inserted the graft into the hole in the occiput. Then I tilted the head back and sewed the graft into place. There were no complications, and he made a splendid recovery. The paralysis has entirely disappeared. Before I operated, if his head tilted forward, he would immediately become paralyzed; and it had to be held back for six to eight hours before the paralysis disappeared. Since the operation, there has not been this trouble.

DR. JAMES T. WATKINS, San Francisco: I want to show you pictures of the spine of a child that died several months after I had performed a Hibbs operation. The morbid process involved the bodies of two vertebrae in the mid-dorsal region, and at our operation we synostosed the laminae of six vertebrae, going well above and below the lesion. Dr. Ely said that his sections showed that the spines had disappeared. By that I suppose he meant that they had lost their configuration as spines and had become fused with the laminae. One can still differentiate them in the picture.

REPORT OF TWO CASES OF SCOLIOSIS  
ACCOMPANIED BY PRESSURE PARALYSIS OF THE  
LOWER LIMBS

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JOHN RIDLON, M.D.  
CHICAGO

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The purpose of this paper is simply to report two cases presenting a condition which, in so far as I know, is unique, namely, a motor spastic paralysis of the lower limbs associated with and apparently depending on scoliosis.

The paralysis in both cases appeared to be in every respect the same as the paralysis we not infrequently see in cases of tuberculous spondylitis, and which we believe to be due to pressure on the anterior surface of the cord from the inflammatory process involving the vertebral bodies.

One of these patients was examined by two eminent neurologists. Their reports will presently appear in this paper. Both of these patients were treated on the convex gas-pipe frame. One was carefully nursed and the paralysis passed off by the end of four months; the other, less well nursed, had gained voluntary control of the movements of the limbs at the end of six months, but the tendon reflexes continued exaggerated.

CASE 1.— Girl, aged 11, was seen by me in June, 1913. She was large and well developed. The spinal curvature had been noticed for some time. There were marked round shoulders, a well marked lumbar curvature to the right with considerable rotation for the degree of lateral deviation, and a slight dorsal curvature to the left which on forward bending showed a marked rotation deformity. Roentgenograms showed a somewhat irregular fifth lumbar vertebra, with a slight lateral curve to the right starting from the deformed vertebra. In the dorsal region there was a short, sharp curve to the left with extreme wedging of the bones, one of which, the ninth, has an extra rib attached to the thicker side.

The patient was treated by daily exercises, and for nearly a year wore a leather corset made over a corrected plaster torso. The girl as a whole looked much straighter at the end of that time. On account of the extreme heat of the summer the corset was left off; but the exercises were continued. At the end of another eight months, the corset not having been resumed, the girl had grown rapidly and had become very stout. She looked straighter, but the roentgenogram showed that the curvature had really increased.

In July, 1915, two years after the first observation, it was reported that she had been walking "queerly" for about two weeks, and had fallen at least twice. For a month or more she had been "uncertain" in her bowel movements, but had had no bladder symptoms.

On examination, her walk showed spasticity, more noticeable in the right than in the left leg; the patellar and Achilles reflexes were exaggerated, and ankle clonus and the Babinski sign were present.

The Roentgen-ray plates read by Dr. Hollis Potter showed "no material change (from former plates) in the anterior posterior view. Transverse view . . . showed wedging in front, but less than to the right side."

Dr. Archibald Church examined the patient and kindly provides the following report:

"About six months ago her mother noticed that she was getting a little clumsy on her feet. About two months ago she commenced to have difficulty in the action of the bowels with a slight sphincter relaxation. She would often feel an inclination to go to stool but experienced inability in defecation, and then perhaps in a few minutes or hours involuntary defecation would take place.

"She complained of no disturbance of sensation, though stating to her mother that her legs, especially the right leg, felt heavy and stiff. More recently she had encountered difficulty in mounting stairs and had fallen once or twice, and walks in an uncertain, rigid manner.

"Upon examination the patient presents a very well developed appearance for a girl of her age. Menstruation has been established and is regular. Her general appearance is one of robust health.

"The face is not symmetrical. The left eye is apparently larger than the right. The left side of the face is decidedly larger than the right, and she has a way of talking almost entirely on the right side of her mouth. But innervation is symmetrical on both sides of the face. There is no evidence of cranial nerve palsy of any kind. Upon extreme deviation of eyes to right or left, very slight nystagmoid movements may be induced. Eye grounds normal.

"The upper extremities show no variation of innervation either for motion, sensation, or the reflexes.

"The abdominal reflexes are elicited with difficulty, owing perhaps to the adipose deposit. The left umbilical reflex is very slight; the right cannot be elicited.

"The lower extremities present very greatly exaggerated knee jerks, and rectus clonus can be demonstrated on the left side. There is distinct ankle clonus also on the left side, somewhat slighter on the right side. Babinski reflex is present on both sides. The toes stand in a retracted hammer position, similar to the foot of Friedreich's ataxia.

"There are no vesical symptoms, although she is not quite sure about holding her urine as well as formerly.

"Sensation objectively tested seems to be normal in all its modes and tenses throughout the body and extremities.

"Thoracic, abdominal and pelvic organs normal. Blood and urine normal.

"Opinion: In my opinion there is pressure on the cord in the region of the sharp dorsal bend, showing itself in the spastic condition of the legs and the motor weakness and reduced voluntary control of the lower abdominal action, sphincter control, and locomotion.

"The condition is apparently congenital, but owing to the increasing weight of the body and the demands of growth, has probably induced cord symptoms during recent years."

The child was placed on a convex gas-pipe stretching frame and cared for continuously by a trained nurse. At the end of four months the reflexes appeared to me to have returned to the normal; and the spine was decidedly straighter. The treatment was continued after a consultation with Drs. J. D. Griffith, Francisco, Skoog and J. N. Jackson.

March 23, 1916, Dr. A. L. Skoog, who had seen and examined the patient very frequently, reported as follows:

"In the history I wish to call particular attention to the observation of both parents that . . . has always had an 'unusually peculiar gait.' My neurological examinations have been made every one to three weeks, the first being made on July 19, 1915.

"The mental state has always been perfectly normal. Her even, placid, uncomplaining and obedient disposition has been striking. The eyelids tightly closed show some tremor. The tongue was protruded mesially but had much incoordinate tremor. There were some nystagmoid movements when the eyeballs were turned to the extreme right or left. No other cranial nerve disturbances. Some tremor was seen in the outstretched fingers. Gait was greatly impaired, caused chiefly by disturbed coordination, left more than right. There was much spasticity at the ankles, less at the knees, and still less at the hips. The foot deformity was marked, having a moderate resemblance of the Friedreich's type, left greater than right. The various leg movements were decidedly ataxic. A mild dysdiadokokinesia was found, left slightly more than right. All deep reflexes were plus and

much more so in the lower extremities. Prepatellar reflexes were pronounced. There was a tendency to right clonus, and a more marked unsustained one on the left. These clonic tendencies disappeared after three or four taps. There was a definite right positive Babinski and a more marked one on the left. A glossy or trophic skin was present in the lower extremities. No sensory disturbances could be elicited.

"Subsequent examinations have shown a slow but quite uniformly continuous improvement. At this time the reflexes are less pronounced. The spastic state is much improved. There is less ataxia in the lower extremities. The positive Babinski has changed to a negative one. The Friedreich's foot and nystagmoid movements continue.

"Conclusions: In my opinion the patient is suffering from some congenital or early developmental defect, involving especially some of the lower coordinating tracts. There has resulted a secondary cord compression from the dorsal vertebral deformity."

CASE 2.— Girl, aged 16, was first seen by me in October, 1914. Her father is a clergyman, and both he and the mother have had "nervous collapses." There is one younger child who is normal. The patient at birth had a spina bifida in the upper dorsal region. When about 9 weeks old she had, by Dr. Jepson of Sioux City, three iodin injections ten days apart into the tumor mass. She walked at 3 years. She was never a rugged child. When about 7 years old her mother noticed that the left shoulder was higher than the right. She was bright and quick in school. When about 14 years old her health began to fail, and she left school at the end of that year. The digestion was bad; she was fed on beef tea and malted milk; she lost weight and strength, but the loss of strength was mainly in the legs. During her fifteenth year Dr. Chase made Roentgen-ray pictures at the Battle Creek Sanitarium, and reported:

"There was a destruction of the bodies of several of the dorsal vertebrae, which I estimate to be the fourth to the seventh, inclusive, the destruction being the most marked between the fifth and sixth. There was a marked curvature of the spine to the left as well as anteroposteriorly. I was unable to demonstrate a perispinal exudate, such as is often seen in true Pott's disease." A "poroplastic cast" was applied and weight and pulley traction. The general health improved after two months. She was losing all motor power in her lower limbs, and after some three months was sent home. The limbs became utterly paralyzed. After another three months there was a slight return of motion in the right foot; after a while motion appeared in the other foot. By the following March (1914) she was able to sway the feet from side to side at will and flex the knees. By July she could move her feet in bed as she wished, but the limbs had not lost their rigid tension.

I first saw this patient the following October (1914). There remained from the spina bifida a mass the size of a small and shriveled peach at about the third dorsal vertebra. There was an extreme curvature of the upper two thirds of the dorsal spine to the left with an extreme degree of rotation deformity and the rib deformity characteristic of scoliosis. She sat in a wheel-chair; she could move her limbs at will, and stand and walk a few steps with help. The patellar and Achilles reflexes were greatly exaggerated.

Returning home after a few days, a distance of about 200 miles, she again lost the use of her limbs. She was put on a convex gas-pipe frame with instructions to remain there constantly. To illustrate the care she had, I will relate what I found when making an unexpected visit in January of this year. She was a block from home at the house of a neighbor, on her back on a soft couch. The wheel-chair and stretching-frame were in front of the house. She was wearing a large padded diaper into which she passed both urine and feces, for a "convenience," her mother said; but the girl said that she knew when she did it, and that she could control both her functions. She has had a daily "internal bath" since she was at the Battle Creek Sanitarium in 1913. Examination showed ankle clonus absent on the right side, and but slightly exhibited on the left side; the patellar reflexes were still greatly exaggerated; but she could move her feet and legs at will. In a word, there had been some considerable improvement, but she was far from recovered from her spastic condition.

I will not offer any theories as to these cases. The condition is new to me.

7 West Madison Street.

#### ABSTRACT OF DISCUSSION

DR. LEONARD W. ELY, San Francisco: I had a case, similar to the one Dr. Ridlon described, with spastic paralysis. The patient would not submit to jacket treatment and the paralysis was slowly increasing when he was last seen.

DR. J. D. GRIFFITH, Kansas City, Mo.: I would say to Dr. Ridlon that the case is still under treatment. We are pursuing it right along. The patient was a very fleshy woman, and very large. She weighed 165 to 170 pounds at the time of submitting to treatment. There was a positive von Pirquet, although this does not mean anything necessarily, I suppose. It is, however, corroborative. How much the therapy had to do with the restoration of the spastic condition it is impossible to tell. She is taking potassium iodid. The waist line was reduced 8 inches during the time she was on the frame, but that may have been due simply to the use of "Kissingen" salts, three times a day, in large doses. I reduced the protein

and, to a great extent, the sugar. I could not cut out all the candy. The other treatment amounted to from 10 to 25 grains of potassium iodid three times a day. She has lost the spasticity and walks naturally in a corset with steel stays in it, keeping up continuous hyperextension. At night, she takes off the corset and goes on the frame; and in the morning she puts on the corset while still lying down.

DR. REGINALD H. SAYRE, New York: I should like to report a couple of cases—one referred to me by Dr. Spitzka, twenty odd years ago—that presented almost identical symptoms with this. I believed it was multiple sclerosis in a child that had lateral curvature; and on careful investigation, it was found that clumsiness in movements of the upper extremity had distinctly antedated the noticing of the lateral curvature in the spine by the mother. Later on, another similar case came under my observation, and five or six years ago, I reported a couple of cases, which I attributed to pressure on the cord by the lateral curvature. In these, however, the history obtained from the parents showed the presence of the incoordinate movements before the spine lesion was noted; and it is hard, I think, to see why a dorsal curvature would give incoordination in the upper extremities, the tremulous tongue and the symptoms mentioned, unless one is expecting a lesion of the upper cord as a consequence of the pressure at the point of twisting.

## NEW METHODS OF PRECISION IN THE TREATMENT OF FRACTURES

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The treatment of fractures is largely a mechanical problem, and in spite of the fact that this is a mechanical age, little progress has been made in the mechanics of fracture treatment. In fact, the assertion has been made that many of the methods and devices in use today might easily be mistaken for implements belonging to the era of the wooden plow. Even the method of applying weights to fractures of the femur, as popularized by Gordon Buck as recently as fifty years ago, would have a familiar look to some of the ancients.

It is true, of course, that advance has taken place in the care of fractures ; but the advance has largely been incidental to the development of roentgenography, and in the direction of technical and instrumental improvements in the operative treatment of fractures.

The simple methods have not received the attention which is their due, and even in the operative methods, the development has been in the direction of applied mechanics. One thing Lane emphatically demonstrated is the fact that successful fracture operations are impossible without efficient instruments and without a technical dexterity in the handling of exposed tissues hitherto unknown.

It is strange in this age of automatic machinery and instruments of precision to see so much dependence placed on the manual treatment of fractures. It is

strange because hands must vary considerably in strength, skill and performance. The tradition "hand made" has lost much of its glamor. There would be no such things as automobiles, aeroplanes or submarines if their parts had to be turned out by hand. When it comes to precision and uniformity, mechanical methods must supersede the manual in the treatment of fractures, as in any other work in which the intelligent application of force is required. Any one who has attempted to exert traction on a broken limb and to hold it in a fixed position appreciates that it is not as simple as it looks. Even skilled hands become unsteady and fatigued. The element of unreliability is always present and increases with the inexperience of those who assist in the undertaking.

The time was when the diagnosis of fractures was made without the mechanical aid of the Roentgen machine, and the time is fast approaching when the treatment will not be undertaken without methods and apparatus of precision. It is impossible to apply force accurately by methods which are necessarily inaccurate. The opportunity for improvement in the simple methods of fracture treatment is abundant, and as these simple methods are made more efficient the necessity for open reduction will diminish.

The time is not far off when fractures will be almost entirely treated in hospitals. In fact, it will be difficult, as well as dangerous, to attempt to do so, because the public will be aware that complete scientific equipment for diagnosis and treatment can be found only in such institutions. There are few communities in which people are not within reach of a fairly modern hospital. Here they can be efficiently and promptly treated and sent home to convalesce. In this way, fracture patients become no burden to a hospital.

At the same time it will be necessary for the hospitals to devote more attention to the care of fracture

cases. The public is becoming educated, and it is a public accustomed to "modern improvements." Moreover, the industrial world, which pays the disability bills in occupational fractures, is becoming interested. Not only must the apparatus be efficient, but its use must be in the hands of men especially trained for the work. It will no longer do to divide the fracture cases into small lots and assign them to men whose chief qualifications are that they are interested and proficient in abdominal surgery.

With the introduction of more precise methods, the treatment of fracture cases will become more systematic. Much of the unnecessary handling of broken limbs will be eliminated. This will save a vast amount of needless suffering and promote the processes of repair. One of the noticeable features will be the dispatch with which these cases will be handled.

There is no reason why a fracture patient entering a hospital should not be placed on a bed and a splint applied which permits physical and roentgenographic examination without disturbing the limb in any way. There is no reason why roentgenograms should not be taken at once, so that when the attending surgeon arrives, the complete record is before him and the permanent treatment can be instituted without delay. This simulates the treatment of surgical fractures (osteotomies) in which almost no difficulty is experienced, because the bones are approximated and immobilized before the muscular contractions have become fixed.

In the treatment of some 3,000 cases of fracture during the last seven years, I have preached and practiced the immediate reduction and immobilization of fractures under ether. During this time, I have never cut or split a cast in anticipation or on account of swelling. In fact, the only cases of extensive swelling or of bleb formation (so commonly associated with fracture) which I have seen are those in which the

treatment was delayed. As I have successfully proved to myself that the mortality and suffering in fracture of the hip in old people is directly due to conservative treatment, so I believe that if we are looking for swelling and trouble, then treat fractures expectantly. If we wait until the swelling disappears, it is only necessary to wait for it will not disappoint us.

## THE TREATMENT OF FRACTURES OF THE FEMUR

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F. E. PECKHAM, M.D.  
PROVIDENCE, R. I.

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### 1. THE MIDDLE THIRD

Fractures of the femur in the middle third have aroused considerable discussion in recent times regarding methods of treatment. Different mechanical methods have been advocated by different surgeons, and finally the open method with the use of Lane plates occupied the center of the stage and caused quite a little excitement.

A fracture is a definite mechanical problem. First of all, a roentgenogram is necessary to see exactly what the condition is, whether transverse, oblique or comminuted. How far the fragments are riding by is also a good thing to know. In these fractures, the result is so easily obtained that, in the great majority of cases, no anesthesia is necessary, and there is no "setting of the bone" in the ordinary acceptation of that expression. Every orthopedic man learned during his early hospital training that an acute tuberculosis of the hip with its muscular rigidity and flexion deformity was overcome by traction. Pain was relieved almost instantly and muscular contraction was overcome by constant, incessant and efficient traction.

In a fracture of the middle third of the femur, traction properly and efficiently applied will just as surely overcome the muscular contraction which is the cause of the fragments riding by, thus producing shortening. For traction to be efficiently applied in this particular condition, countertraction must be equally efficient. Here is where the treatment, as usually prescribed in

textbooks, fails. Efficient countertraction or counter-extension is considered to be accomplished by elevating the foot of the bed. Nothing could be further from the truth. Elevation of the bed is usually (although not always) necessary; but to get really efficient counterextension, a well padded perineal band is placed in the groin, one of the straps going over the front of the body, the other going beneath the body, with a pulley at the head of the bed. Weights are then added to both the foot and the head of the bed, varying according to the necessities in the individual case. In the direct extension, anywhere from 10 to 40 pounds may be necessary. The foot of the bed may be elevated as usual and then about one-half the weight necessary in the direct extension may be added for the counter-extension. If 30 or 40 pounds are necessary for the extension, then use 15 pounds for the counterextension. This makes a traction in each direction, thus pulling the fragments apart in the longitudinal direction of the leg.

If this "two way" pull is kept up constantly, incessantly and efficiently, there is usually only one thing can happen, and that is, the fragments will be pulled down so that, in the middle third, they will almost fall into apposition. Coaptation splints may be placed about the leg, but they do not need to be really adjusted and tightened until the leg is down to length. Now and then, a strand of tissue may be caught in such a way as to hold one end from just going into position. Under such conditions, pressure and counterpressure by pads of sheet cotton beneath the coaptation splints will usually correct. In case there should be a large piece of muscle interposed to prevent apposition, then all that is necessary is to take the patient to the operating room, bed and all, without removing the extension weights. After the usual preparation, make the incision, expose the fragments, remove the obstruction, and the ends will either fall into apposition or can be

easily held by the coaptation splints over a light surgical dressing.

This method would seem to reduce the treatment of fractures in this location to their very simplest terms, and I wish to report some cases treated in this manner:

CASE 1.—Mr. A. An oblique fracture of the femur with about 2 inches' shortening. Extension of about 40 pounds with foot of bed elevated and counterextension of 15 pounds. At end of ten days with coaptation splints tightened, the fragments were down and together (Fig. 1). Discharged from hospital with no shortening. This case was treated about one year ago, and a letter from the man states that he is at work (putting in elevators) and that he walks without a limp.

CASE 2.—Mrs. B. This was an oblique fracture of the femur with  $1\frac{1}{2}$  inches' shortening. Extension of 35 pounds with foot of bed elevated, and counterextension of 15 pounds. At end of two weeks (Fig. 2 A) the fragments had been pulled over an inch apart, i. e., the leg had been pulled down until it was that much too long. Removing 10 pounds from the direct extension, the leg shortened up till the fragments were in apposition, as shown in Figure 2 B. This was treated a little less than a year ago, and in April, 1916, the patient reported at my office with no shortening, no limp, and the Roentgen ray shows the condition in Figure 2C.

CASE 3.—Boy, aged 4 years. Oblique fracture in middle third of femur. Extension of 15 pounds with counterextension of 10 pounds easily brought the leg down to length (Fig. 3 A), but the Roentgen ray showed the fragments "back to back" (Fig. 3 B) instead of edge to edge. Under ether, an attempt was made to readjust them, but with no result. Then the boy was taken to the operating room in his bed, with extension and counterextension in full force (Fig. 4). The leg was cleared of adhesive straps from the knee up and prepared for operation *in situ*. An incision was made through the skin, and then the muscle bluntly dissected to the bone, where a piece of muscular tissue was removed from between the fragments. The broken ends fell into apposition immediately. The skin was sutured and a light surgical dressing applied, and boy, bed and all returned to the ward. Union promptly resulted, with a perfect leg, as shown in Figure 3 C.

## 2. FRACTURES OF THE HIP

Appreciating that with extension and counterextension, the leg can hardly help coming down to length, it occurred to me that with proper mechanics, fractures of the hip could be readily treated without the use of the plaster spicas. A number of hips at different times

having been opened through the anterior incision for the purpose of exploration and freshening of the broken surfaces, it was ascertained in this way ocularly that if the leg was pulled down to length and strongly internally rotated, the broken ends became locked in apposition. The getting down to length is easily accomplished by efficient extension and counterextension, as already described. The internal rotation is easily accomplished by rotary pulls by means of adhesive plaster straps extending around the leg from the top, over the inside and under the leg, then passing up over a particularly wide T splint. In this way the extreme degree of internal rotation may be obtained and held. With these mechanics kept perfectly efficient, the fragments are kept locked in apposition as verified by the Roentgen ray.

I wish to report two cases to demonstrate the efficiency of the mechanics:

CASE 4.—A man sustained a fracture through the great trochanter with shortening of  $1\frac{1}{4}$  inches. The leg was pulled down and internally rotated, thus bringing the broken surfaces into accurate apposition. The recovery was perfect, with possible flexion.

CASE 5.—A boy sustained a separation of the epiphysis of the right hip, but continued to walk around on it, although lame and painful. Three months after the accident, the boy was brought for examination. The Roentgen ray showed the condition. Efficient extension and counterextension with strong internal rotation brought the hip down into position. Union was obtained, however, and scarification of the surfaces became necessary, but the roentgenograms are exhibited to demonstrate the possibilities of the mechanics as described above.

The results in these two cases were so encouraging that others have been treated in a similar manner with similar results. When treated in this way, the back and whole body is easily reached with alcohol and powder, and the patients are much more comfortable than those I have seen in plaster spicas.

**Fig. 1 (Case 1).**—Oblique fracture of femur: *A*, fragments pulled down to length; *B*, *C*, result of gradually tightening the coaptation splints.

**Fig. 2 (Case 2) —**Oblique fracture of femur; *A*, fragments pulled too far apart by over an inch; *B*, apposition obtained by lessening the weight; *C*, condition a little less than a year after the injury.

Fig. 3 (Case 3).—Oblique fracture in middle third of femur: *A*, leg pulled down to length; *B*, fragments back to back instead of in proper apposition; *C*, union some months afterward.

**Fig. 4.—Method of extension and counterextension.**

**Fig. 5.—Wound the day the stitches were removed; method of operating.**

**Fig. 6 (Case 4).—Line of fracture, *x-y*, with fragments pulled into apposition; *o*, lesser trochanter knocked off.**

**Fig. 7 (Case 4).—Power of active flexion.**

**Fig. 8 (Case 5).—Separation of epiphysis at upper end of femur,  
three months after accident.**

**Fig. 9 (Case 5).—Apposition obtained by extension and counterextension.**

## ABSTRACT OF DISCUSSION

ON PAPERS OF DRs. HAWLEY AND PECKHAM

DR. FRED H. ALBEE, New York: We employ the Hawley table in all cases of fracture in any part of the body where it is difficult to get replacement and hold the fragments firmly in position.

DR. J. T. RUGH, Philadelphia: I want to speak of three cases of ununited fracture of the hip, one in a woman past sixty years of age. Two of these cases have been entire successes, and the third patient is not cured. In a case of old fracture of the neck of the femur a graft was placed. That patient, at the end of many months, is walking well, with perfect results. A case of twisted fracture was also an excellent result. In another case there was some comminution in the head of the bone. When the graft was placed it, unfortunately, did not penetrate as far into the innermost piece of the head of the femur as it should. It has been a year and a half since the operation, and the patient is not yet walking. I could not understand why until I found that the graft did not penetrate all the fragments. I think that the secret of success is to get the peg through both or all the fragments. Then it does not make any difference whether the peg is round or square. If it is through in proper position, the result will be good.

DR. JOHN RIDLON, Chicago: As to the Hawley leverage device for congenital dislocation of the hip, I would say, in the first place, that it is not necessary to use any leverage device to replace a congenital dislocation of the hip. In the second place, it is dangerous to use it; because, with a leverage device like that and the one on the Bartlett apparatus, it is possible to fracture the neck of the femur. We fractured one with the Bartlett apparatus. As to Dr. Peckham's fracture work, it is possible to pull down some fractures of the shaft of the femur; and when you have pulled down three or four, you think that you can do this in all cases; but you cannot. I have had a case, in a man of great muscle development where 58 pounds weight for 8 days did not reduce the displacement at all. We have to use traction, in such cases, to an enormous amount to pull the fragments down; and when they have been pulled down, they do not always "drop into place," and we cannot always manipulate them into place. In this case, when the leg was opened and the bones pulled down, with a space of half an inch between the ends of the fragments, and the traction slowly relaxed, instead of the fragments going end to end, they went just where they were before; and there was no tissue between the ends, muscle or otherwise.

DR. H. R. ALLEN, Indianapolis: I enjoyed the demonstration of the use of the operating table with all of its fancy attachments and complications and believe it would be very

gratifying to a man who feels that plaster of paris dressings are essential or scientific. Personally, I do not use such dressings for any human condition that I have ever seen. I do not like the use of inadjustable splints that conceal the results. I prefer splints made of wire and adhesive plaster. They are light, cheap, adjustable and sanitary, and permit inspection at all times. Such splints do not conceal errors. If you choose you can apply the splint before operating, then when the operation is through you are through. These splints do all that a plaster splint can do and as much more as you desire. They are easy to make and easy to apply and they are comfortable and do what is expected of them. I agree with Dr. Ridlon. But Dr. Peckham has never found a case that could not be reduced by traction alone. Dr. Ridlon and I and others have found plenty of this variety. Suppose you have a square ended fracture with over-riding in a thigh whose hamstrings are tight on simple knee extension, how would you expect the jagged ends of the bone to slip past each other into place. If you unlock the thigh muscles by flexing the knee then the fragments will easily go to place. Then, after flexed reduction you lock the broken ends tight together by complete knee extension. There is a use for this mechanical tightening of the hamstrings but this use is not absolutely dependable. Dr. Peckham's method of traction will reduce most all of the spinal fractures of the thigh, but what good is reduction by any method unless you follow it up with some guaranteed method of maintaining reduction. Really, the maintenance of reduction is all that counts since every bone will unite in the position in which it is held and in no other position.

DR. J. C. A. GERSTER, New York: Dr. Howard D. Collins has devised a most ingenious and convenient traction bandage-sling for use in connection with Dr. Hawley's table. Before applying the bandage two pieces of felt  $\frac{1}{4}$  inch thick and 4 inches wide are laid next to the skin. One, 6 inches long is laid in front of the ankle over the dorsum of the tarsus; the other, 4 inches long is laid over the tendo achilles. The bandage is of stout canton flannel, 3 inches wide and 2 yards long. The bandage forms two symmetrical hitches, one in each side of the ankle. Each hitch forms a Y, one limb passing in front, and one behind the ankle. Traction is made by pulling on the stems of the Ys. As soon as traction is released, constriction ceases. This spontaneous relaxation of the hitches would not take place if they were so applied that they formed Ts instead of Ys. By appropriate adjustment, varying the site to suit each case, the points where the limbs and stems of the Ys meet can be so placed that the subsequent traction suffices to hold the foot correctly inverted and at right angles to the leg. As soon as plaster has set the projecting stems of the Ys, by which traction is maintained, are cut off flush with the cast. The blueness of

the toes from interference with the venous return, present up to this time, subsides immediately, because constriction ceases on relaxation of traction. The advantages of nail extension are many for cases in which, on account of associated trauma to skin, etc., or on account of long standing shortening, the customary plaster of paris or traction methods are unsuitable. In fractures, properly treated from the very start, nail extension will not be indicated in more than 4 to 5 per cent. of the cases.

DR. EDWIN W. RYERSON, Chicago: It is perfectly evident that many fractures of the femur can be treated as has been outlined by Dr. Peckham, but some cannot, and other treatment must be used. Dr. Albee said that we need exact doweling to secure union of the bone fragments. That is desirable, without doubt; but I have a perfect case in which I took the bone-spike from the tibia and filled it nearly round with a rasp and file, without using a doweling instrument. This was a complete fracture of the neck of the femur, incurred a year previous, a so-called intracapsular fracture. Another point I wish to refer to is the use of the motor drill for making holes in the upper end of the femur. I do not think you need it. I believe that it winds up the soft tissues too much, as Dr. Allen said a year or so ago. It is better to have the drill point in a plain hand-drill, because the work is then easier and safer, and you can control the drill better in going through the bottom of the trochanter. You should not start the drill on the trochanter itself, but just below the trochanter, and go obliquely upward and inward. In one of the roentgenograms shown the bone-peg was inserted at a right angle to the shaft of the femur. This is not the way I prefer to do. I go down under the overhanging border and drill upward and inward, and this is easier with the hand-drill than with the motor-drill. I have found the use of the Hawley table very satisfactory. I think that it solves many of our problems. In a clinic where much fracture work is done, I consider it invaluable.

DR. FRANK E. PECKHAM, Providence, R. I.: I do not think that anyone can succeed every time. I selected three pretty bad cases; and they resulted very well. I think that the less metal we put in, the better. I would suggest as a good motto, "M. M. J."—Minimize Metallic Junk.



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